STATUS OF AIRS LEVEL 2 VERSION 4.0

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OUTLINE

New quality flag indicators

Daily results for September 6, 2002

Monthly mean results for January 2003, January 2004

IR tuning considerations

Proposed research for Version 5.0

RATIONALE FOR NEW QUALITY FLAG INDICATORS

The main improvement in Version 4.0 is new quality flag indicators

Old approach was one “size fits all” - accept or reject everything in a profile

- Accept means produce IR/microwave retrieval
- Reject means produce (and flag bad) microwave/strat IR retrieval
- Cloud fields computed based on selected retrieval state
- Tight control was needed to eliminate most poor SST cases
- Eliminated most cases, especially over land
- Monthly mean climate parameters could not be produced in many areas

New approach uses different flags for different quantities, different purposes

- Poor SST does not imply poor T(p) or q(p)
- Parameters useful for climate need not be as accurate as for data assimilation
  - Should be unbiased (or consistently biased)

QUANTITIES USED IN QUALITY FLAG TESTS

$\alpha\varepsilon$	Effective cloud fraction
Liquid water	
IRX	Difference between observed AMSU channel 5 and value computed from IR solution
RB2	Difference between $T(p)^{AMSU}$ and $T(p)^{AIRS}$ in lowest 2 km
Amp factor	Cloud clearing noise amplification factor
qual temp	Convergence of T(p) retrieval
qual surf	Convergence of surface property retrieval
η_{rej}	Convergence of ability to solve for η - impacted by poor surface emissivity
A_{eff}	Estimated noise including cloud clearing errors - impacted by poor surface emissivity ($A^{(1)}_{eff}$ computed after MW retrieval, $A^{(4)}_{eff}$ computed after final retrieval)
Δ_{tskin}	Difference between final product and first product skin temperature Large difference indicates low cloud problems
NOAA score	Indicates problems with some observed radiances

QUALITY FLAG TESTS

Order of increasing difficulty to pass

0) Fails test 1)
   Use microwave/strat-IR state to compute cloud products
   Everything flagged bad except cloud products

1) Stratospheric Temperature Test - temperature profile good above 200 mb
   $\alpha\varepsilon < 0.9$ and cloud clearing passes minimal quality control
   Use coupled AIRS/AMSU retrieval state if Stratospheric Temperature Test is passed

2) Constituent profile test
   Slightly more stringent cloud clearing quality control

3) Mid-tropospheric Temperature Test - T(p) good above 3 km
   Tighter quality control on cloud clearing and T(p) convergence
   $\hat{R}_i$ flagged good

4) Lower Tropospheric Temperature Test - T(p) good above surface

5) Loose SST test - for non frozen ocean only

6) Tight SST test - for non frozen ocean only

QUALITY FLAG TEST THRESHOLDS

	Version 3.7	Version 4.0					
		1) T(p) good 200mb & up	2) q(p) good O_3(p) good	3) T(p) good 3km & up	4) T(p) good above surface	5) SST good Loose	6) SST good Tight
$\alpha\varepsilon$	80%	90%	90%	90%	90%	90%	90%
Liquid water	.03	x	**.03**	.03	.03	**.01**	.01
IRX	1.0	x	x	**2.0**	2.0	2.0	2.0
RB2	1.0	x	x	**2.0**	2.0	2.0	2.0
Amp factor	5.0	x	**8.0**	**2.0**	2.0	2.0	2.0
qual temp	4.0	x	x	**0.75**	0.75	0.75	0.75
qual surf	4.0	x	x	**0.75** (x)	0.75 (x)	0.75	0.75
η_{rej}	1.5 (3)	x	**8.0**	**2.0 (6.0)**	**1.5** (**1.5**)	1.5	1.5
$A_{eff}^{(1)}$	x	200	200	**30** (x)	30 **(30)**	**9**	**5**
$A_{eff}^{(4)}$	10 (x*)	x	x	x	**15** (x)	**8**	8
Δ_{tskin}	1.5 (3)	x	x	x	**1.5**	1.5	1.5
NOAA score	x	10	10	**4**	**4**	**1.2**	1.2

Numbers refer to non-frozen ocean
Numbers in parenthesis refer to everything but non-frozen ocean if different
x means test not used
Tightened tests bold
* $A_{eff}^{(4)}$ > 10 over non-frozen ocean flagged lowest 3 km no good in Version 3.7

JPL QUALITY INDICATORS

Three Values

0 - Unqualified good - highest quality
1 - Good for climate purposes - good quality
2 - Do not use

Cloud Parameters

0 - Based on IR/MW retrieval
1 - Based on MW/strat-IR retrieval
2 - Only if clouds cannot be produced

Top Temp

0 - If strat test is passed
2 - Otherwise

Constituents

0 - If const test is passed
2 - Otherwise

Mid Temp and Clear Column Radiances

0 - If mid-trop test is passed
2 - Otherwise

Low Temp

0 - If low-trop test is passed
1 - If mid-trop test is passed but not low trop test
2 - Otherwise

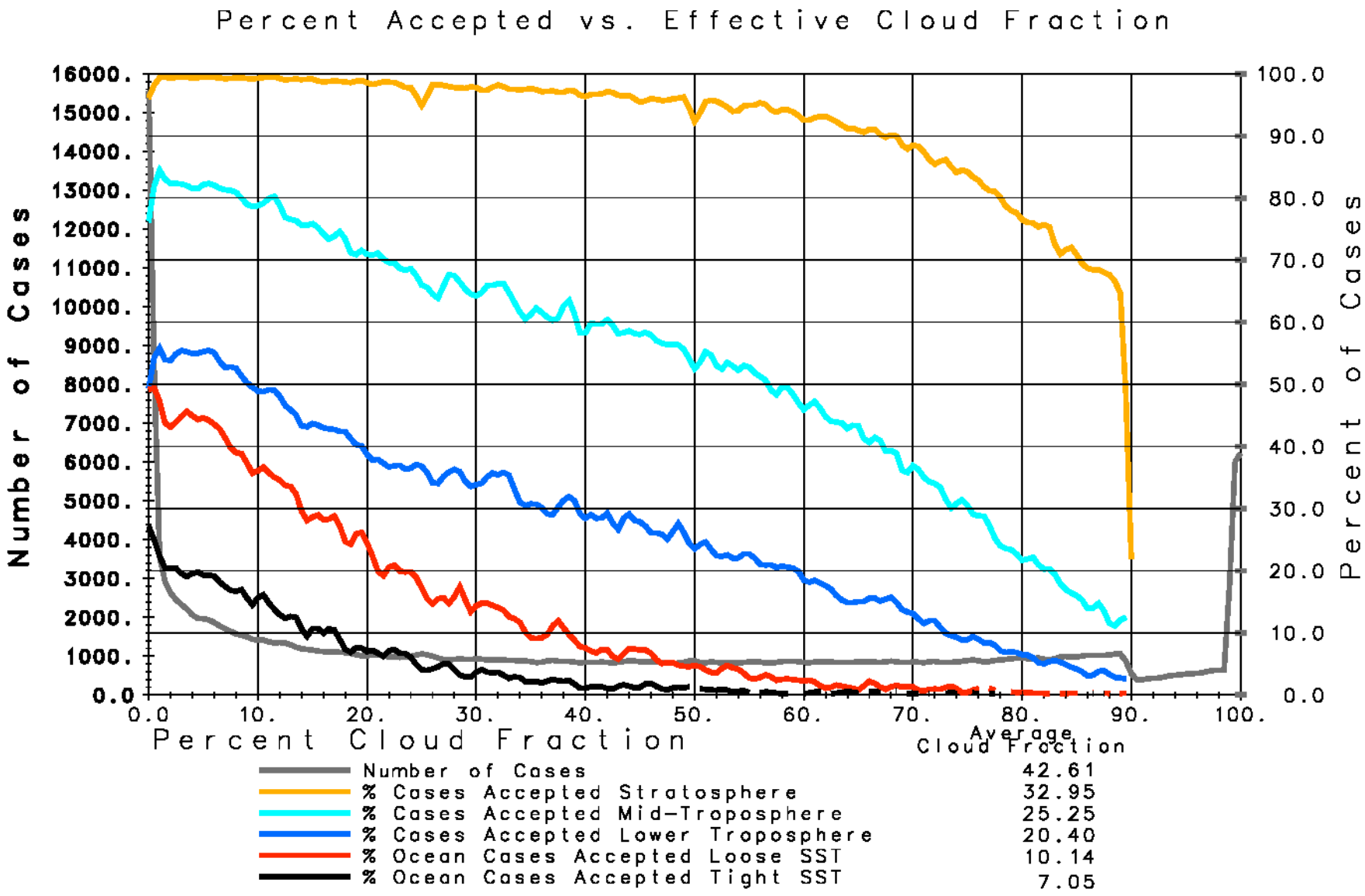
Non Frozen Ocean SST, Emissivity

0 - If tight SST test is passed
1 - If loose SST test is passed but not tight SST test
2 - Otherwise

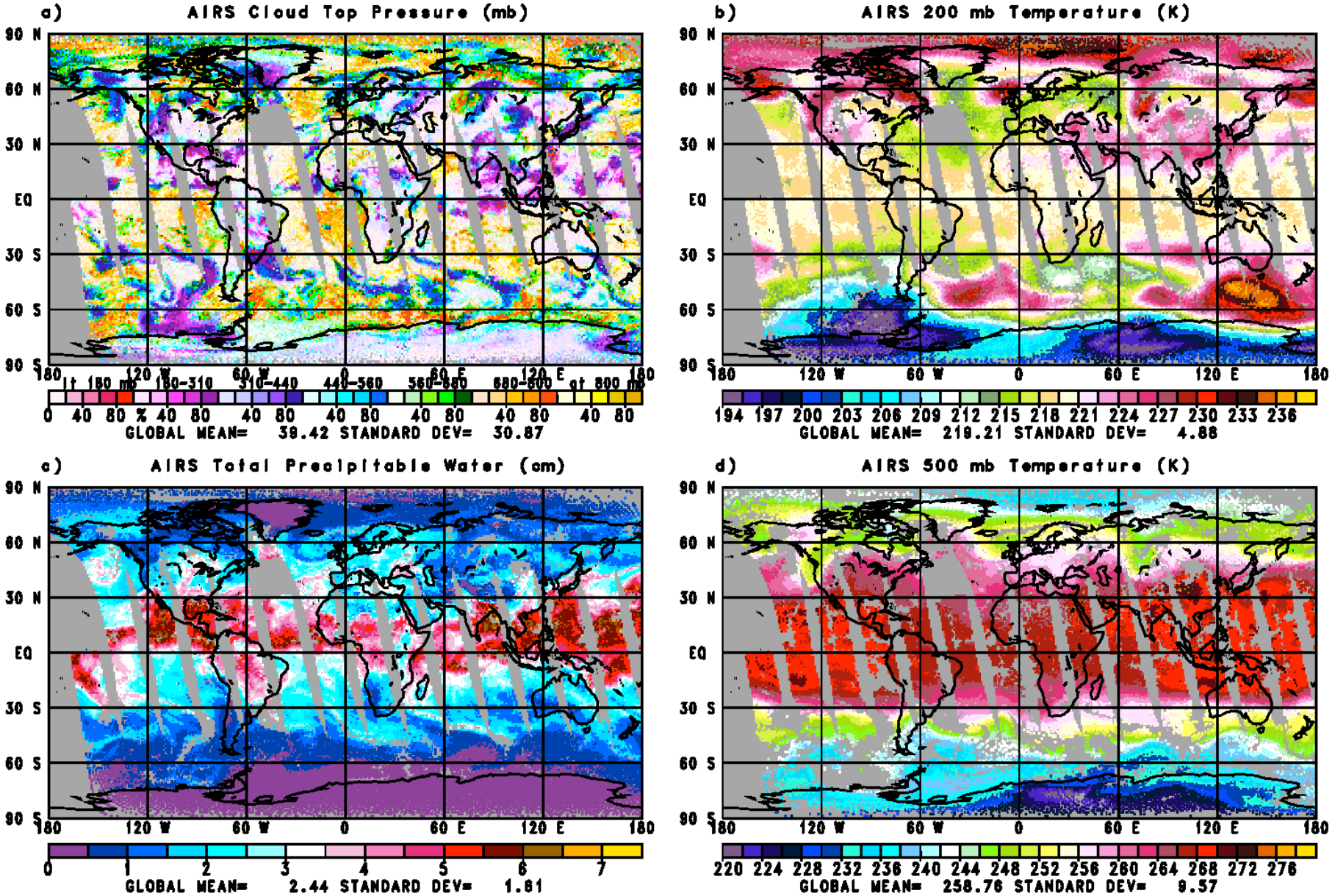
Other Skin Temp, Emissivity

0 - If tight SST test is passed(never happens)
1 - If mid-trop test is passed
2 - Otherwise

JPL also uses coarse level by level reasonableness checks based on range of RTA validity

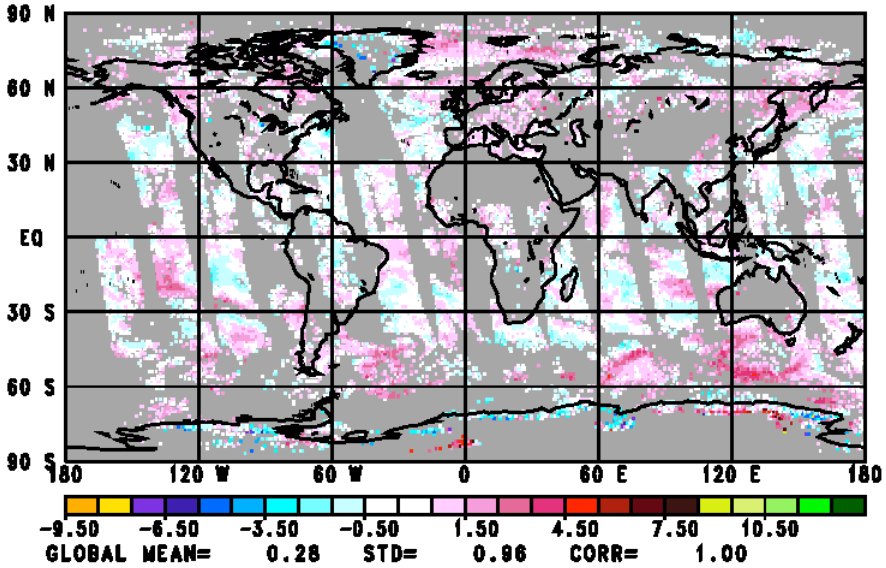

Percent Accepted vs. Effective Cloud Fraction
Number of Cases
Percent of Cases
Percent Cloud Fraction
16000.
15000.
14000.
13000.
12000.
11000.
10000.
9000.
8000.
7000.
6000.
5000.
4000.
3000.
2000.
1000.
0.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
Average Cloud Fraction
Number of Cases 42.61
% Cases Accepted Stratosphere 32.95
% Cases Accepted Mid-Troposphere 25.25
% Cases Accepted Lower Troposphere 20.40
% Ocean Cases Accepted Loose SST 10.14
% Ocean Cases Accepted Tight SST 7.05

September 6, 2002
1:30 PM



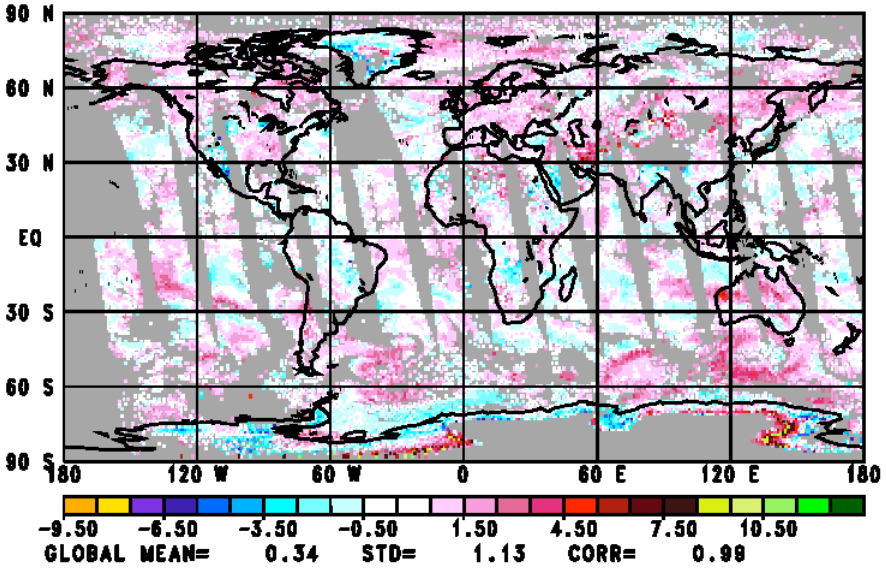
Temperature Differences
AIRS minus ECMWF
September 6, 2002

700 mb Temperature (K)
Lower Tropospheric Temperature Test



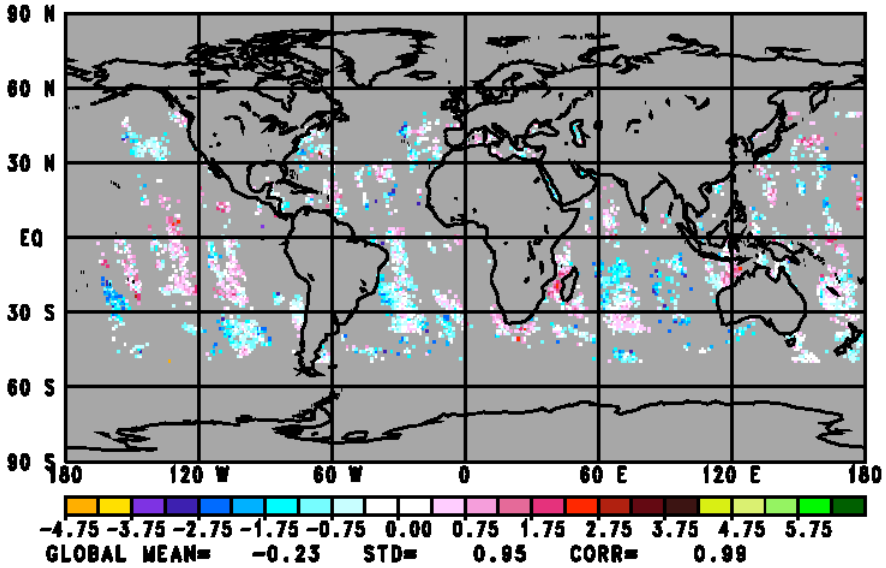
GLOBAL MEAN= 0.28 STD= 0.96 CORR= 1.00

700 mb Temperature (K)
Mid Tropospheric Temperature Test



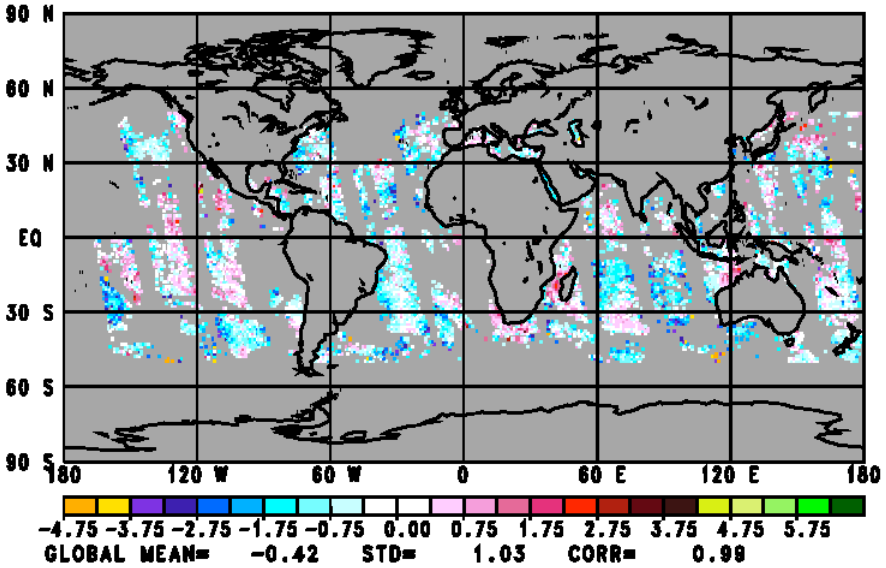
GLOBAL MEAN= 0.34 STD= 1.13 CORR= 0.99

Surface Skin Temperature (K)
Tight Sea Surface Temperature Criteria

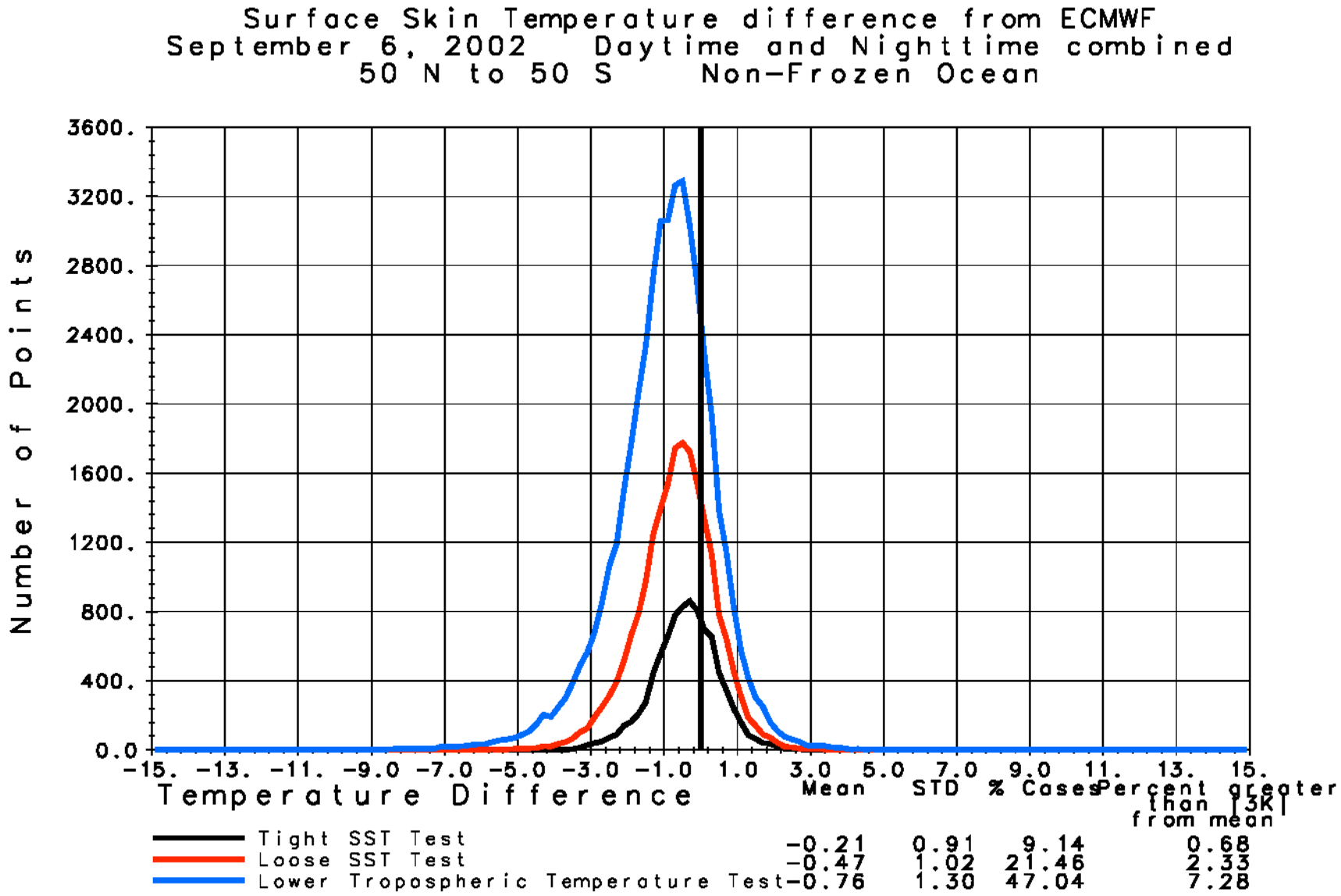


GLOBAL MEAN= -0.23 STD= 0.95 CORR= 0.99

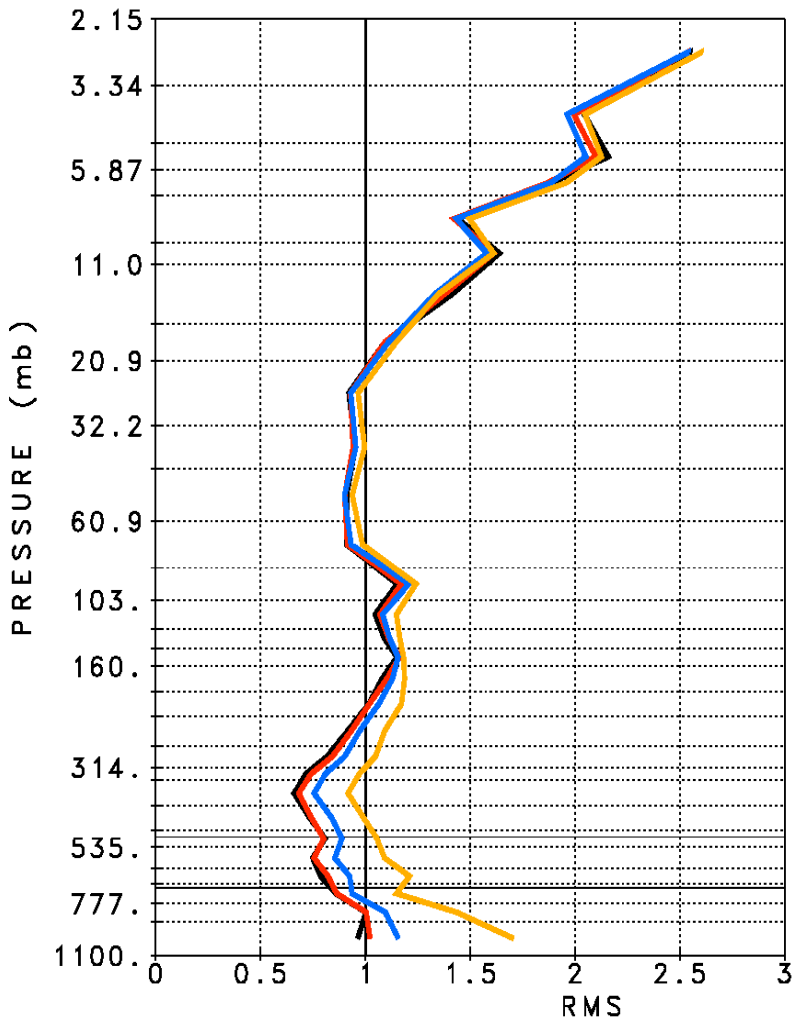
Surface Skin Temperature (K)
Loose Sea Surface Temperature Criteria



GLOBAL MEAN= -0.42 STD= 1.03 CORR= 0.99

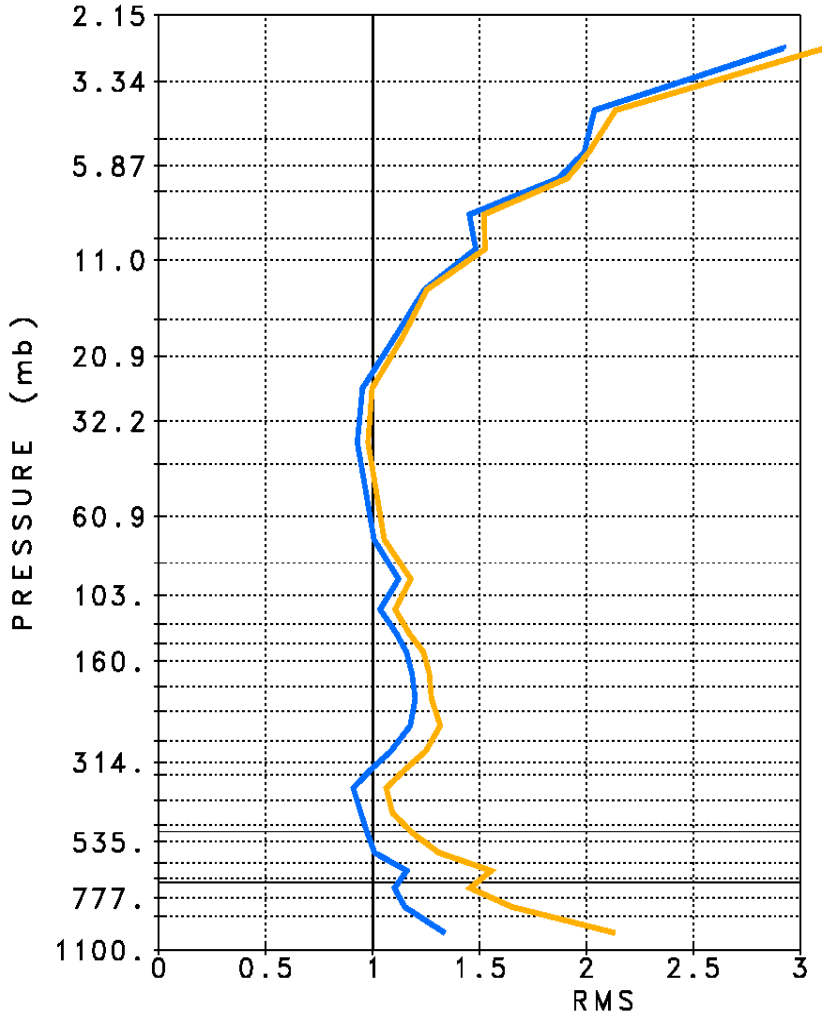

Surface Skin Temperature difference from ECMWF
September 6, 2002 Daytime and Nighttime combined
50 N to 50 S Non-Frozen Ocean
Number of Points
3600.
3200.
2800.
2400.
2000.
1600.
1200.
800.
400.
0.0
-15. -13. -11. -9.0 -7.0 -5.0 -3.0 -1.0 1.0 3.0 5.0 7.0 9.0 11. 13. 15.
Temperature Difference
Mean STD % Cases Percent greater than |3K| from mean
Tight SST Test -0.21 0.91 9.14 0.68
Loose SST Test -0.47 1.02 21.46 2.33
Lower Tropospheric Temperature Test -0.76 1.30 47.04 7.28

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002 50N to 50S Ocean

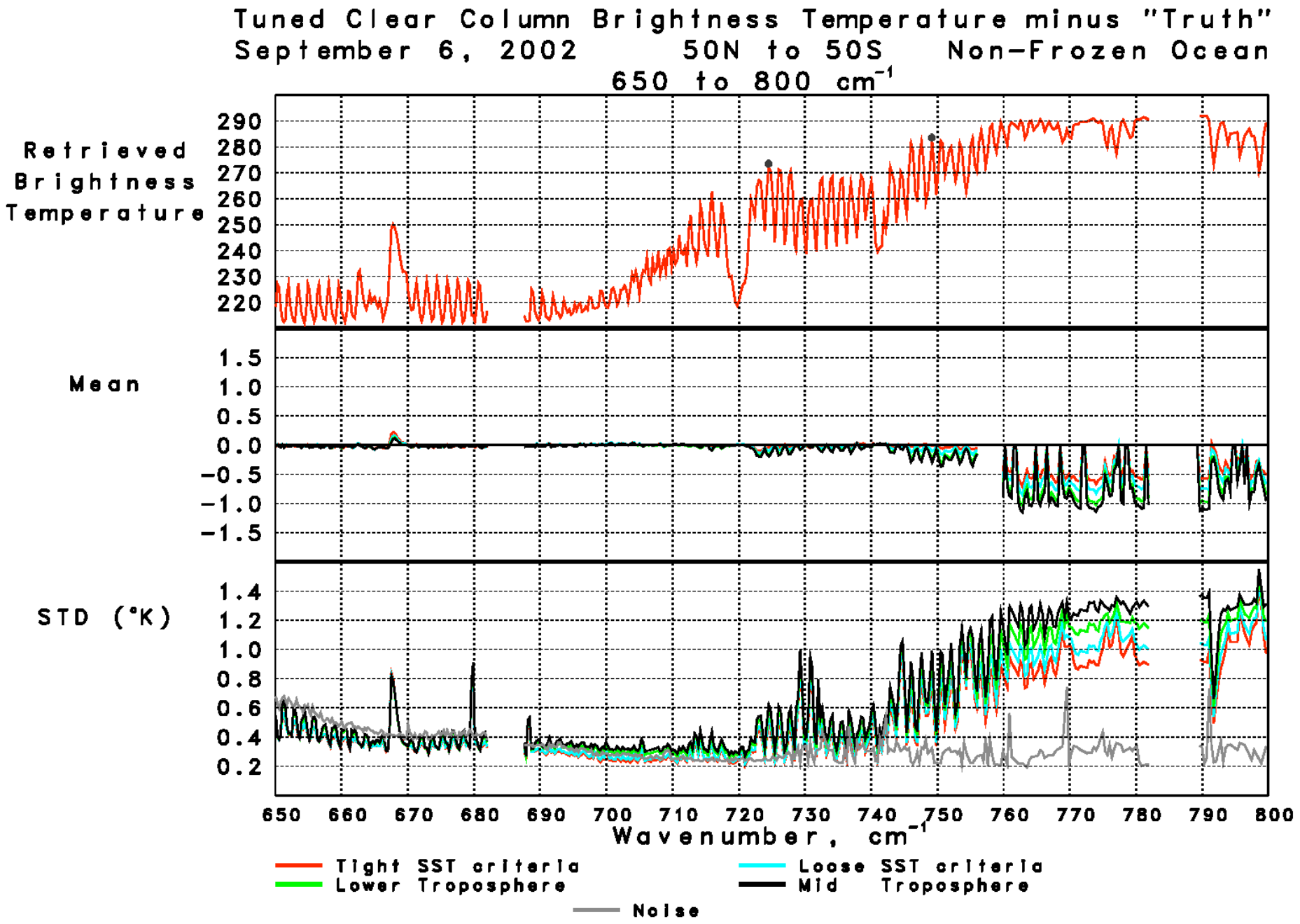


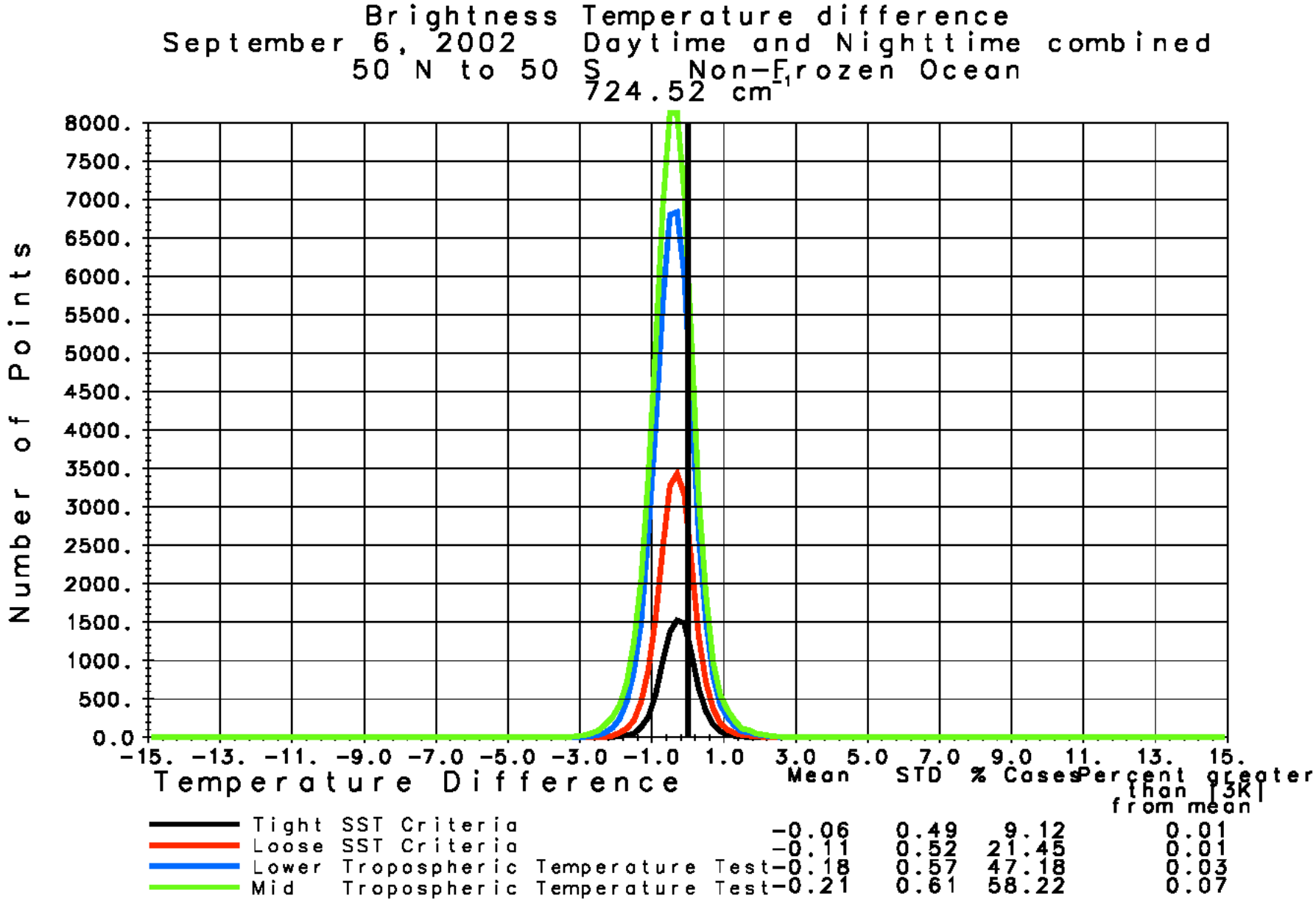
Mid Troposphere		Lower Troposphere		
8838	9.14%	8838	9.14%	Tight SST criteria
20764	21.46%	20763	21.46%	Loose SST criteria
56367	58.27%	45502	47.04%	Troposphere good
84145	86.98%	84142	86.98%	Stratosphere good

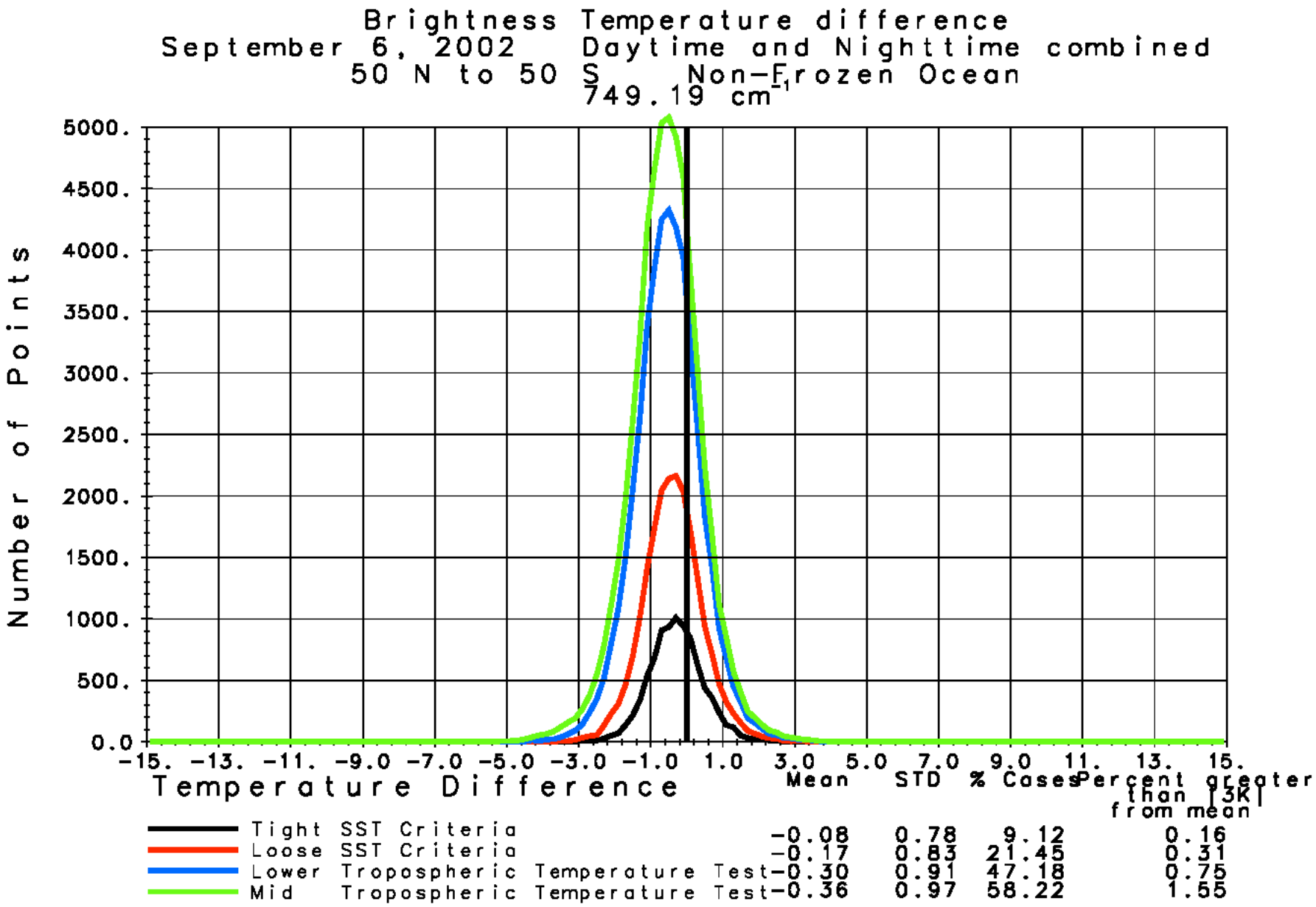
LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
All cases



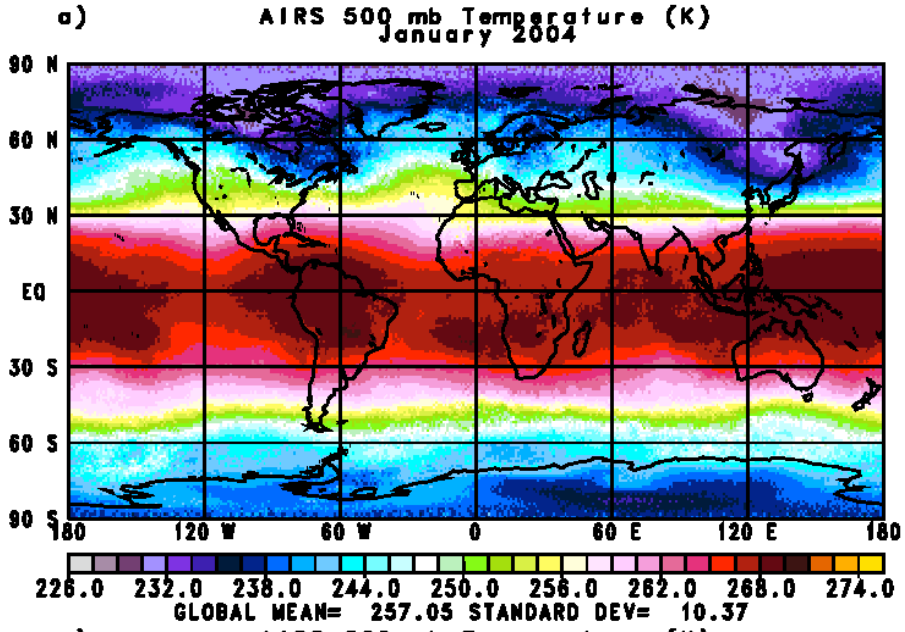
Mid Troposphere		Lower Troposphere		
125732	52.39%	69058	28.77%	Troposphere good
197210	82.17%	197210	82.17%	Stratosphere good

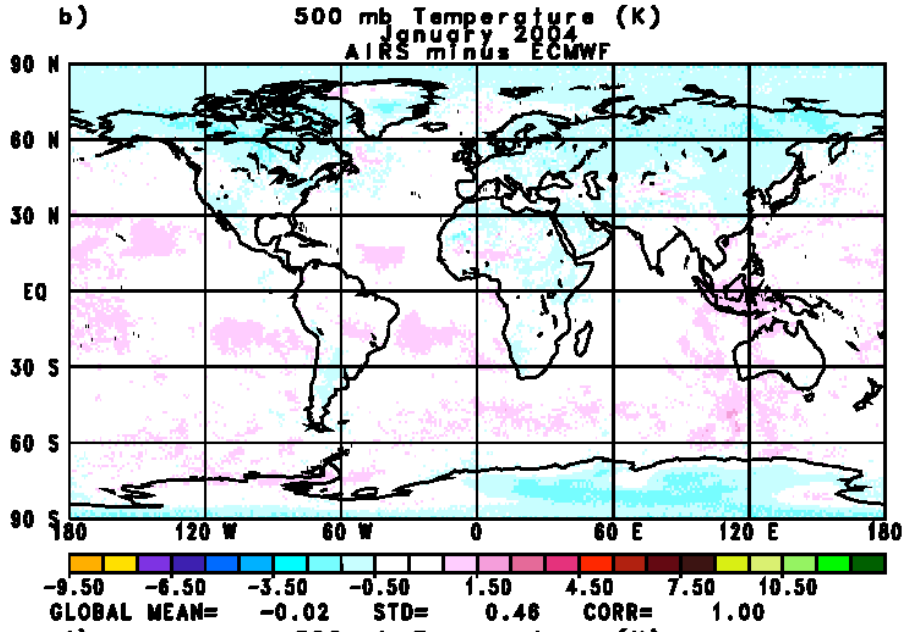

Tuned Clear Column Brightness Temperature minus "Truth"
September 6, 2002 50N to 50S Non-Frozen Ocean
650 to 800 cm-1
Retrieved Brightness Temperature
290
280
270
260
250
240
230
220
Mean
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
STD (°K)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800
Wavenumber, cm-1
Tight SST criteria
Loose SST criteria
Lower Troposphere
Mid Troposphere
Noise

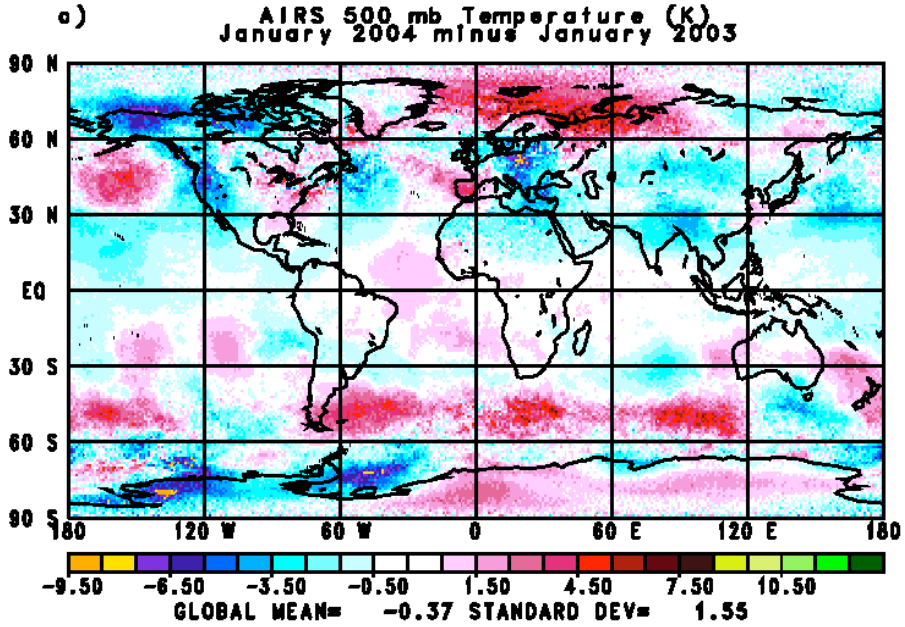

Brightness Temperature difference
September 6, 2002 Daytime and Nighttime combined
50 N to 50 S Non-Frozen Ocean
724.52 cm-1
Number of Points
8000.
7500.
7000.
6500.
6000.
5500.
5000.
4500.
4000.
3500.
3000.
2500.
2000.
1500.
1000.
500.
0.0
-15. -13. -11. -9.0 -7.0 -5.0 -3.0 -1.0 1.0 3.0 5.0 7.0 9.0 11. 13. 15.
Temperature Difference
Mean STD % Cases Percent greater than |3K| from mean
Tight SST Criteria -0.06 0.49 9.12 0.01
Loose SST Criteria -0.11 0.52 21.45 0.01
Lower Tropospheric Temperature Test -0.18 0.57 47.18 0.03
Mid Tropospheric Temperature Test -0.21 0.61 58.22 0.07

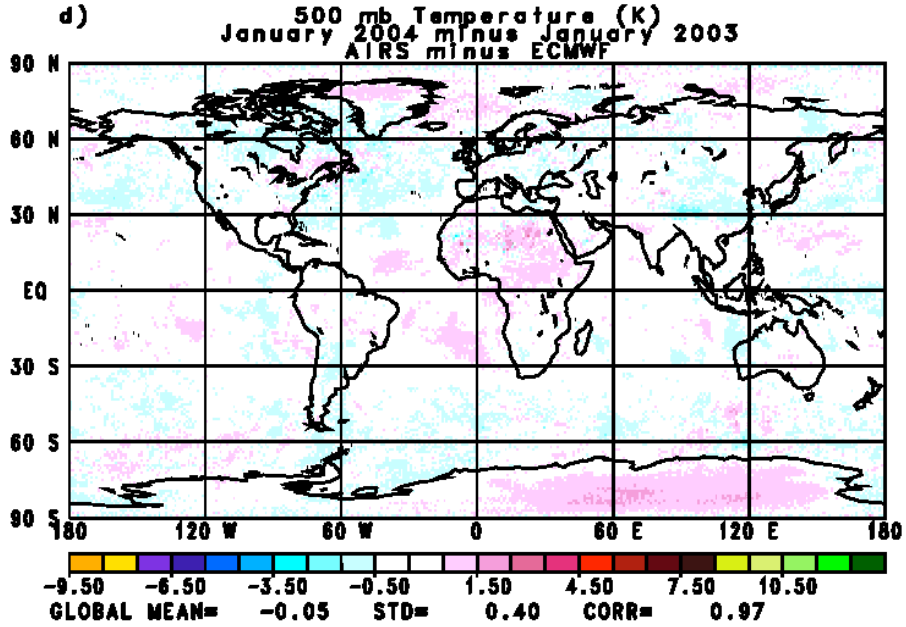

Brightness Temperature difference
September 6, 2002 Daytime and Nighttime combined
50 N to 50 S Non-Frozen Ocean
749.19 cm-1
Number of Points
5000.
4500.
4000.
3500.
3000.
2500.
2000.
1500.
1000.
500.
0.0
-15. -13. -11. -9.0 -7.0 -5.0 -3.0 -1.0 1.0 3.0 5.0 7.0 9.0 11. 13. 15.
Temperature Difference
Mean STD % Cases Percent greater than |3K| from mean
Tight SST Criteria -0.08 0.78 9.12 0.16
Loose SST Criteria -0.17 0.83 21.45 0.31
Lower Tropospheric Temperature Test -0.30 0.91 47.18 0.75
Mid Tropospheric Temperature Test -0.36 0.97 58.22 1.55

500 mb Temperature (K)

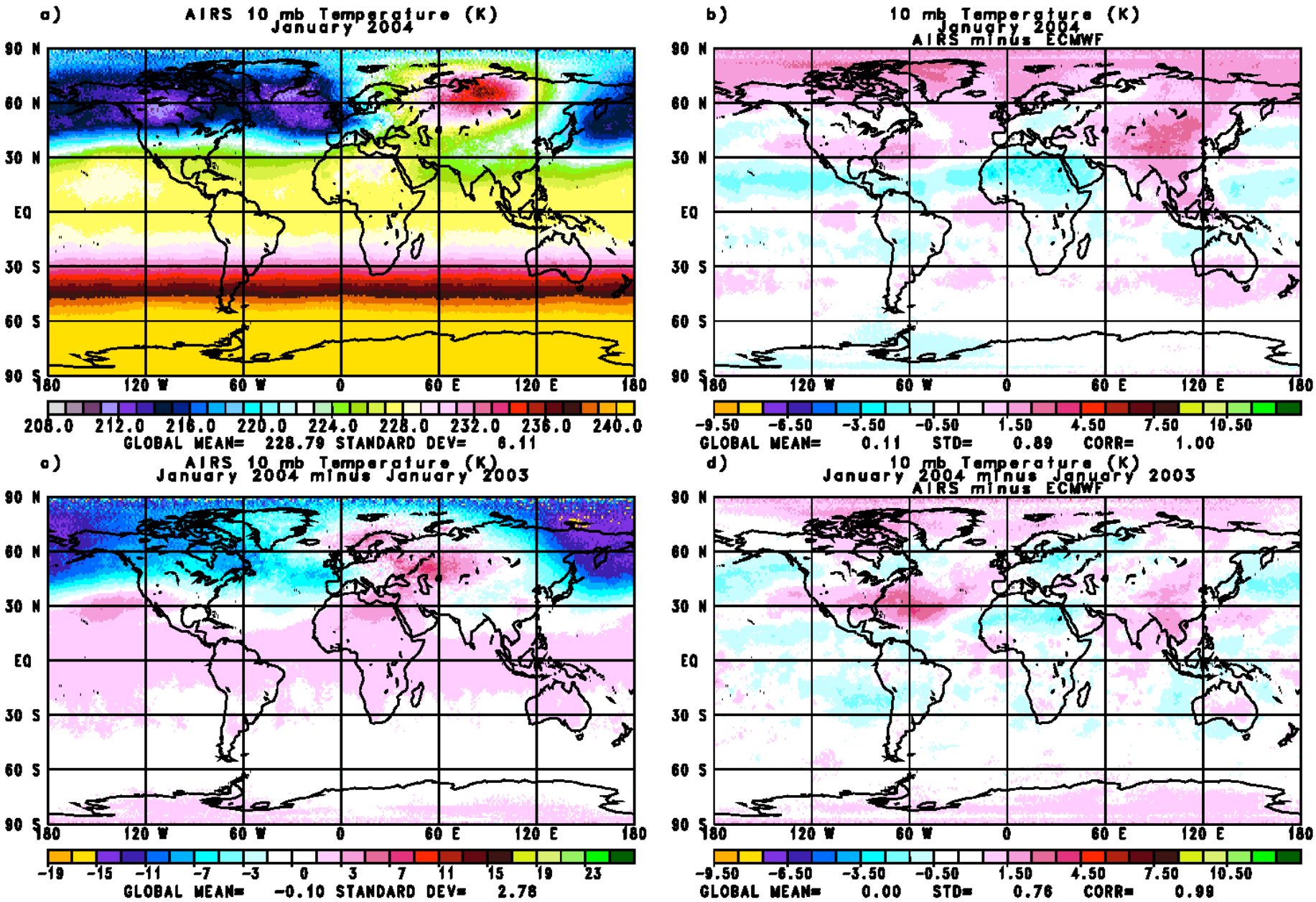




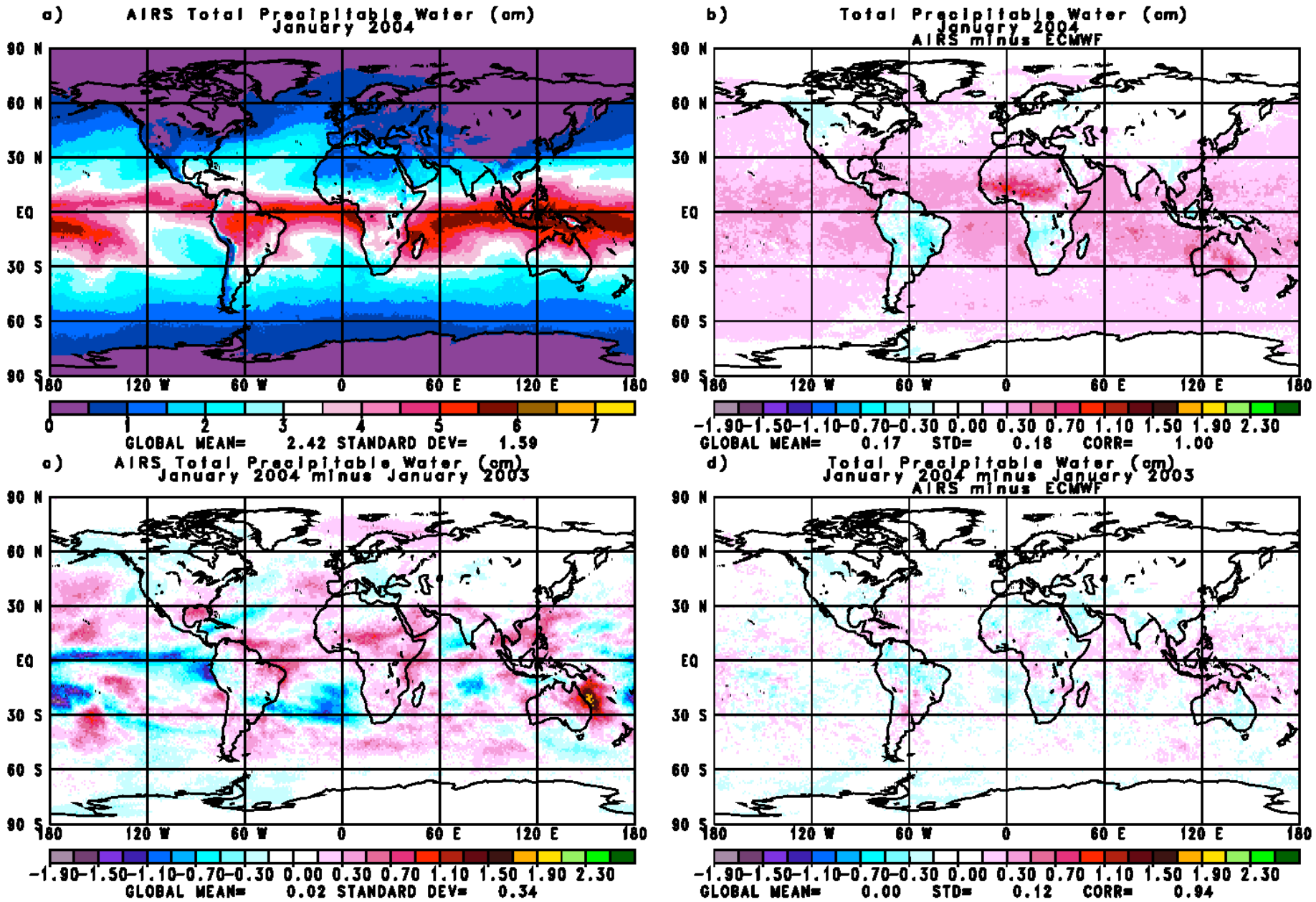




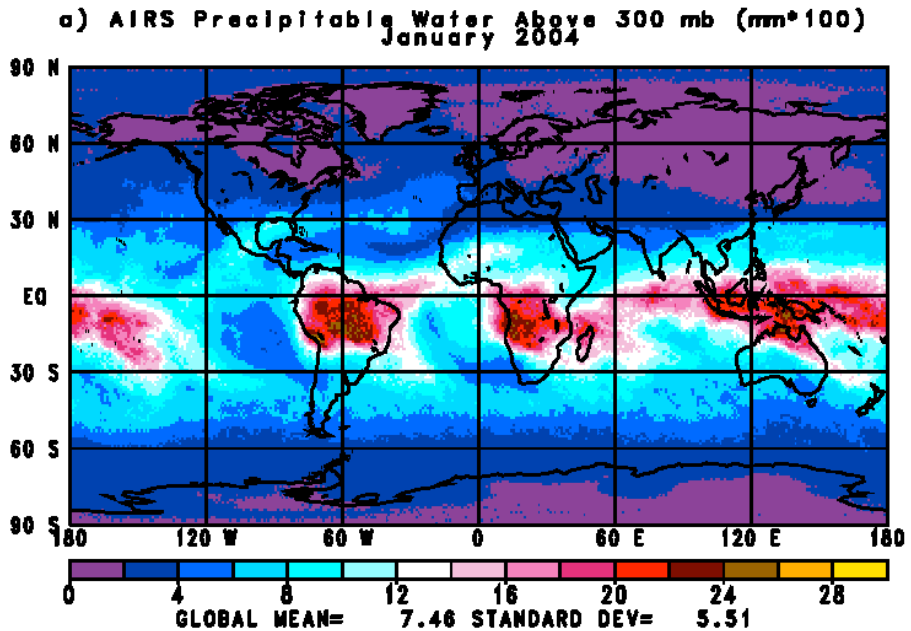
10 mb Temperature (K)

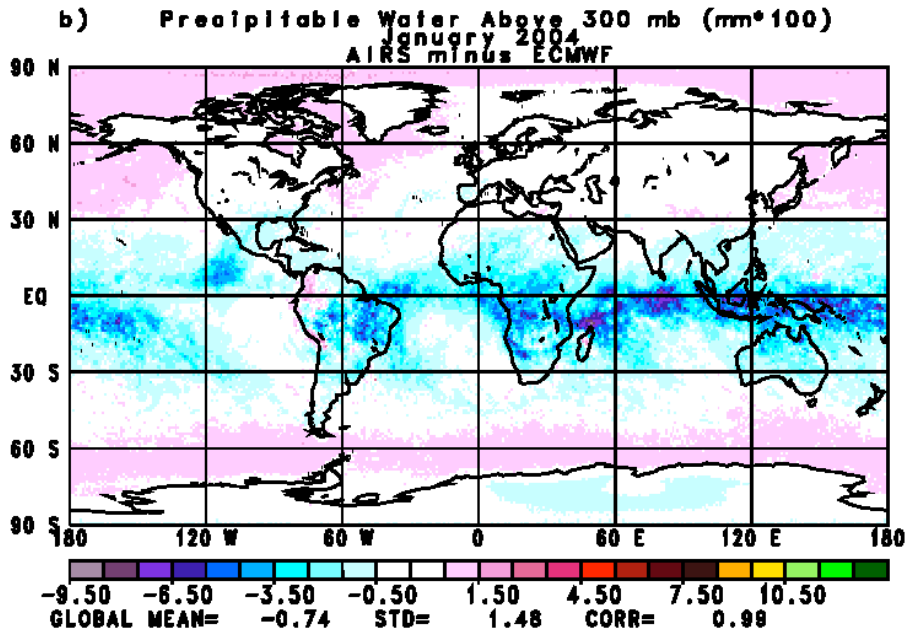


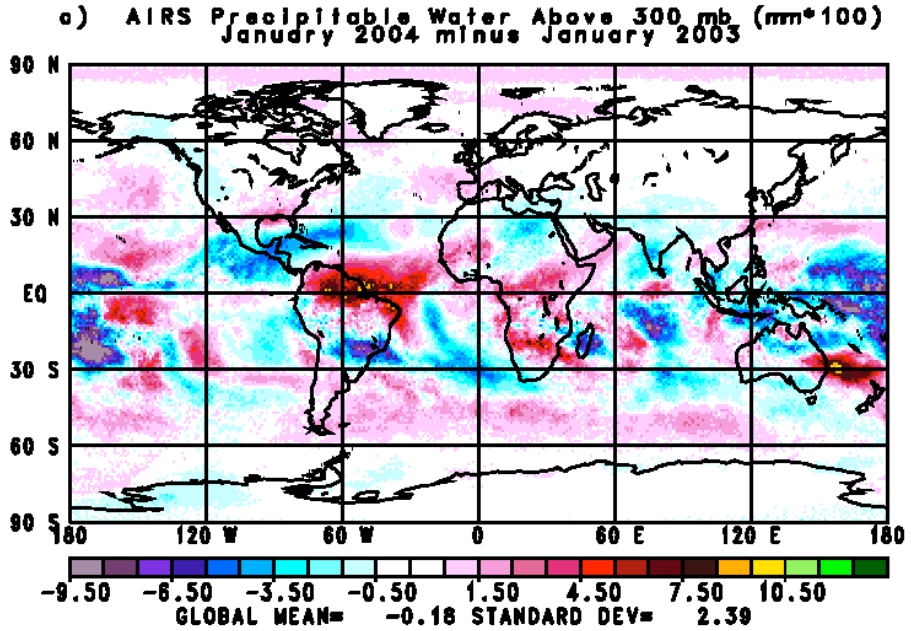
Total Precipitable Water (cm)

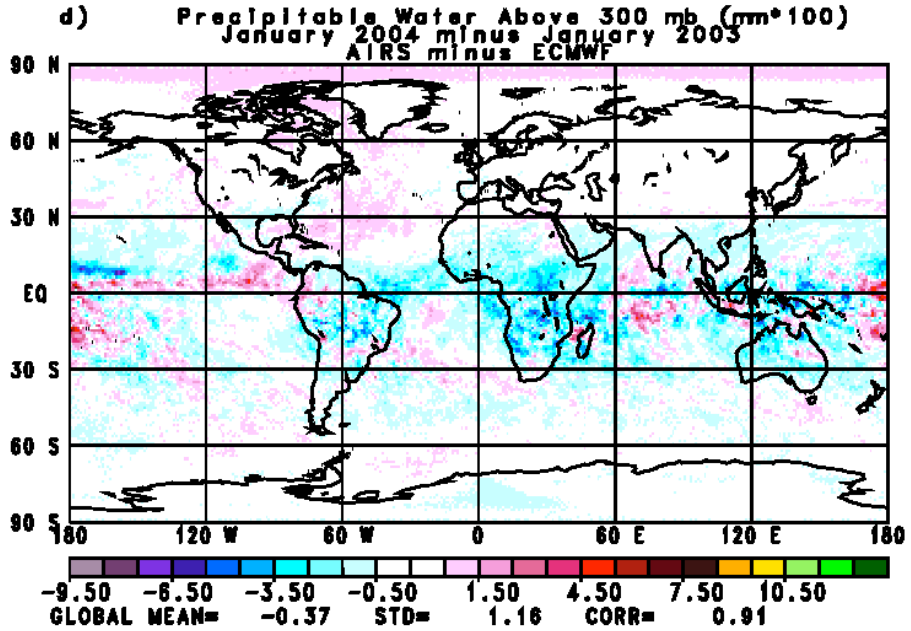


Precipitable Water Above 300 mb (mm*100)

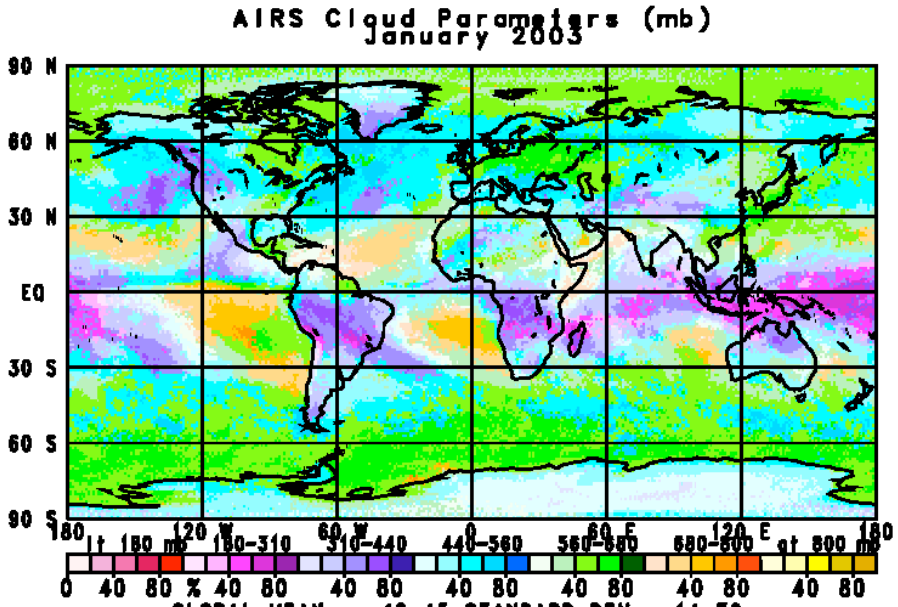


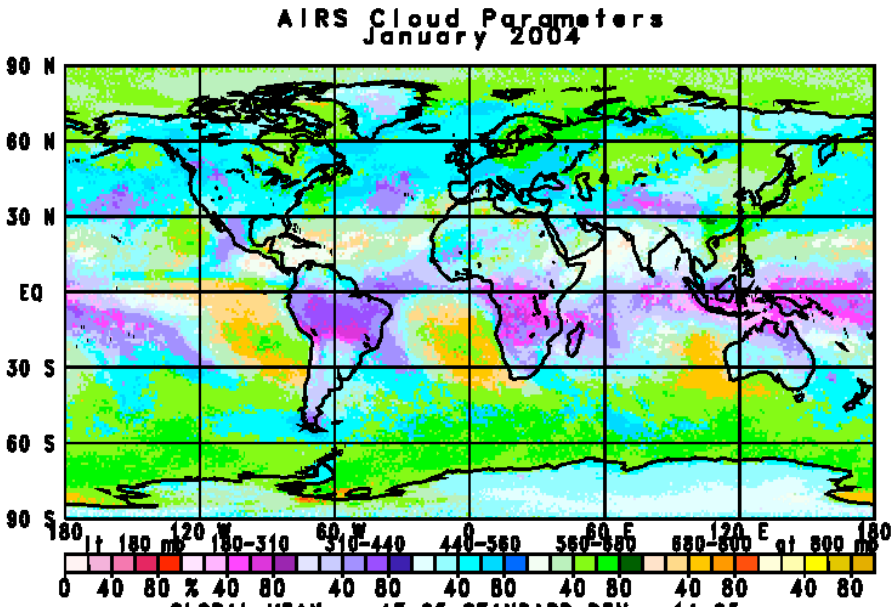


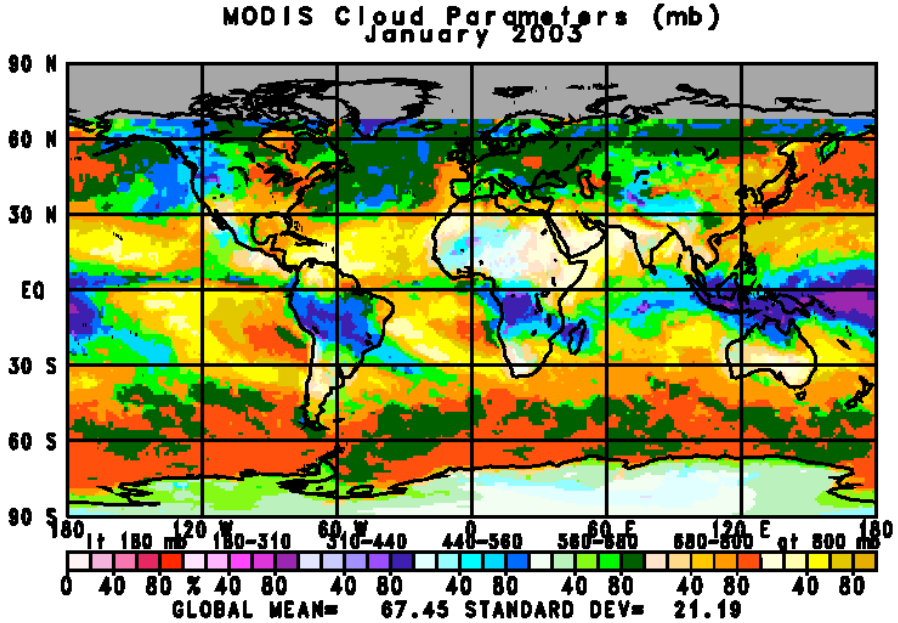


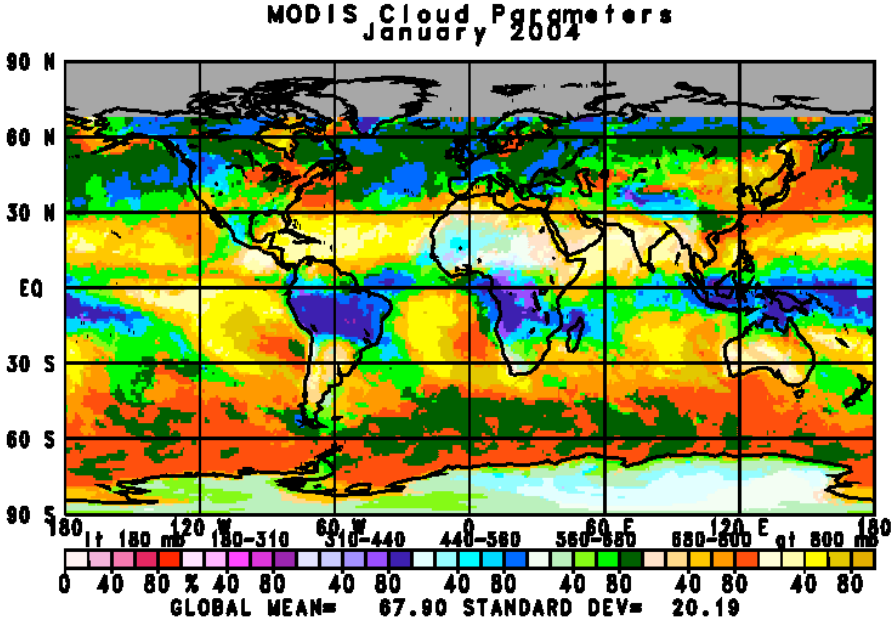


Cloud Parameters

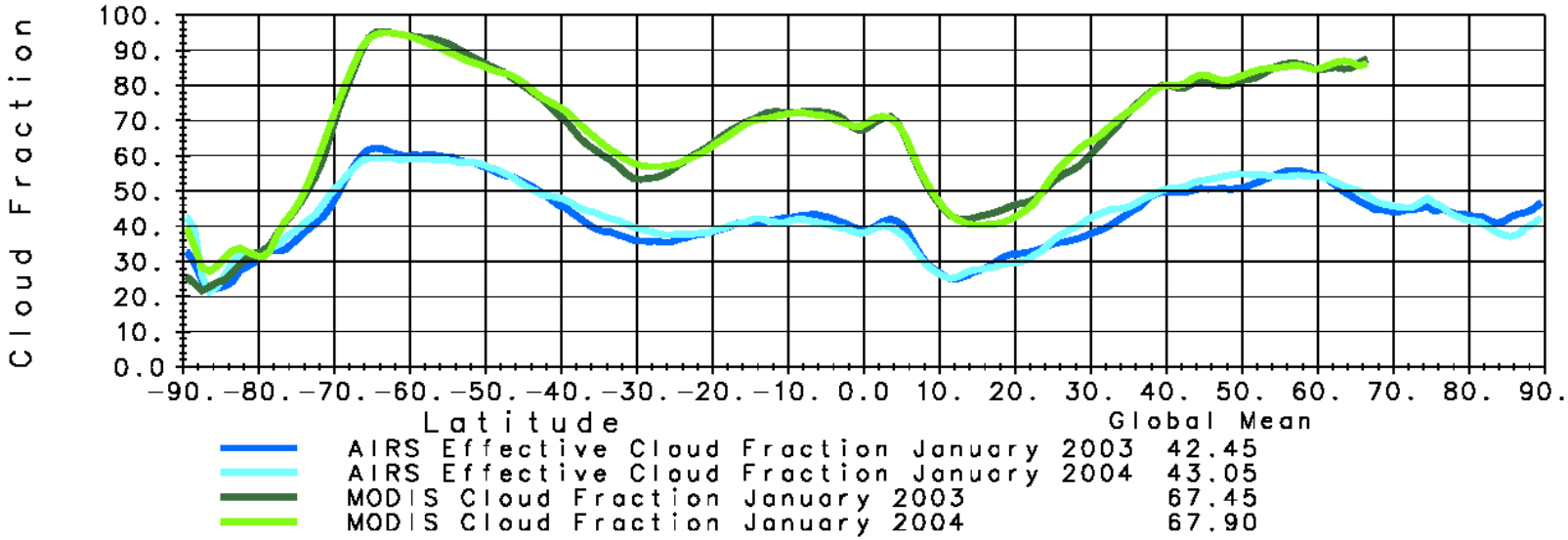






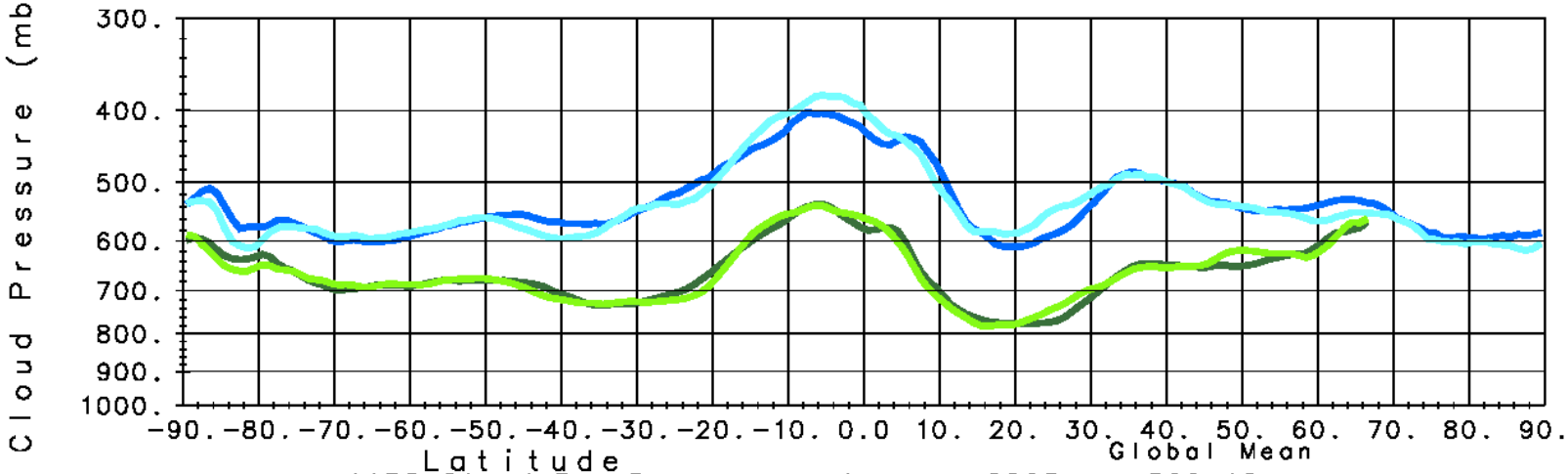


Cloud Fraction as a Function of Latitude



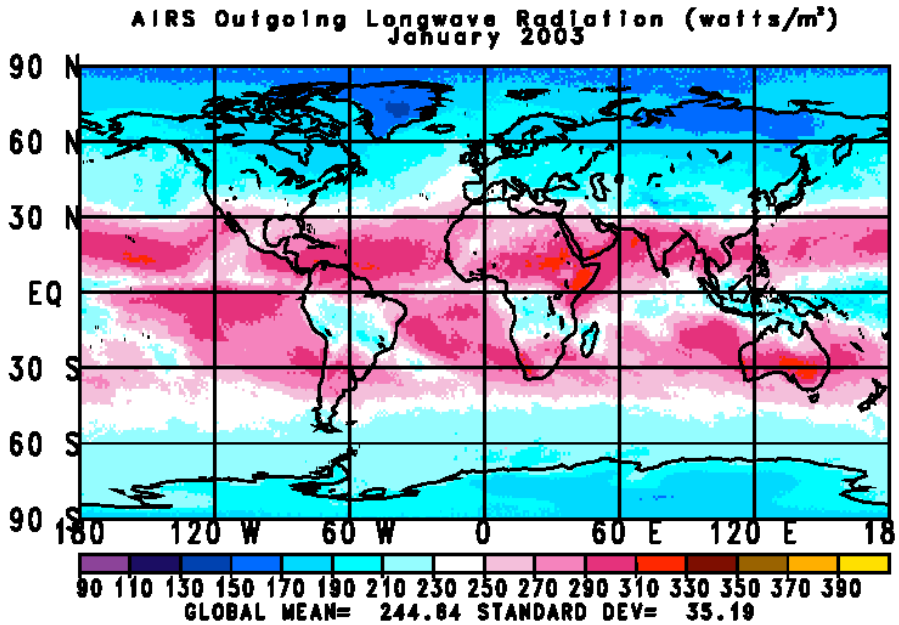
	Global Mean
AIRS Effective Cloud Fraction January 2003	42.45
AIRS Effective Cloud Fraction January 2004	43.05
MODIS Cloud Fraction January 2003	67.45
MODIS Cloud Fraction January 2004	67.90

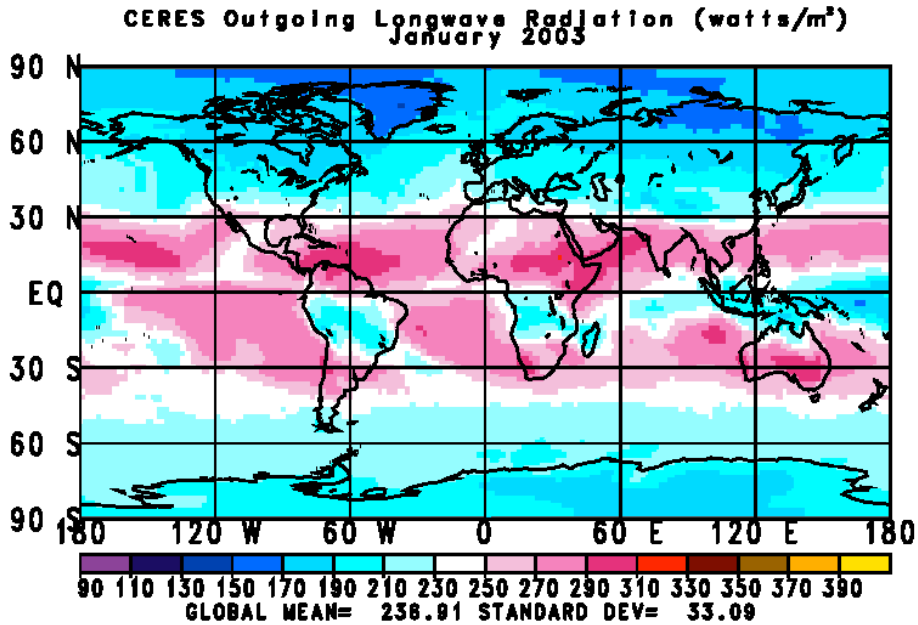
Cloud Top Pressure as a Function of Latitude

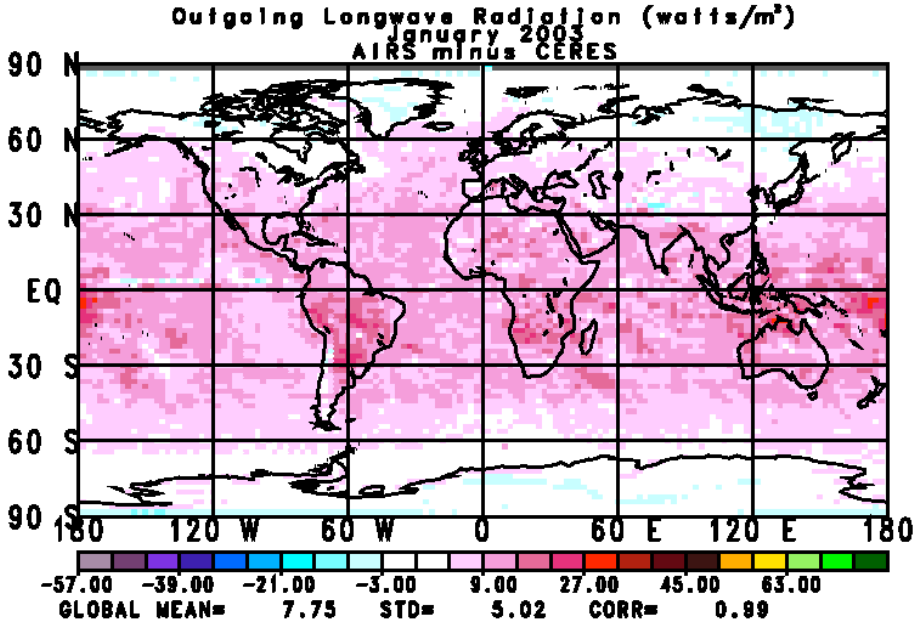


		Global Mean
AIRS Cloud Top Pressure	January 2003	526.42
AIRS Cloud Top Pressure	January 2004	523.94
MODIS Cloud Top Pressure	January 2003	674.91
MODIS Cloud Top Pressure	January 2004	673.83

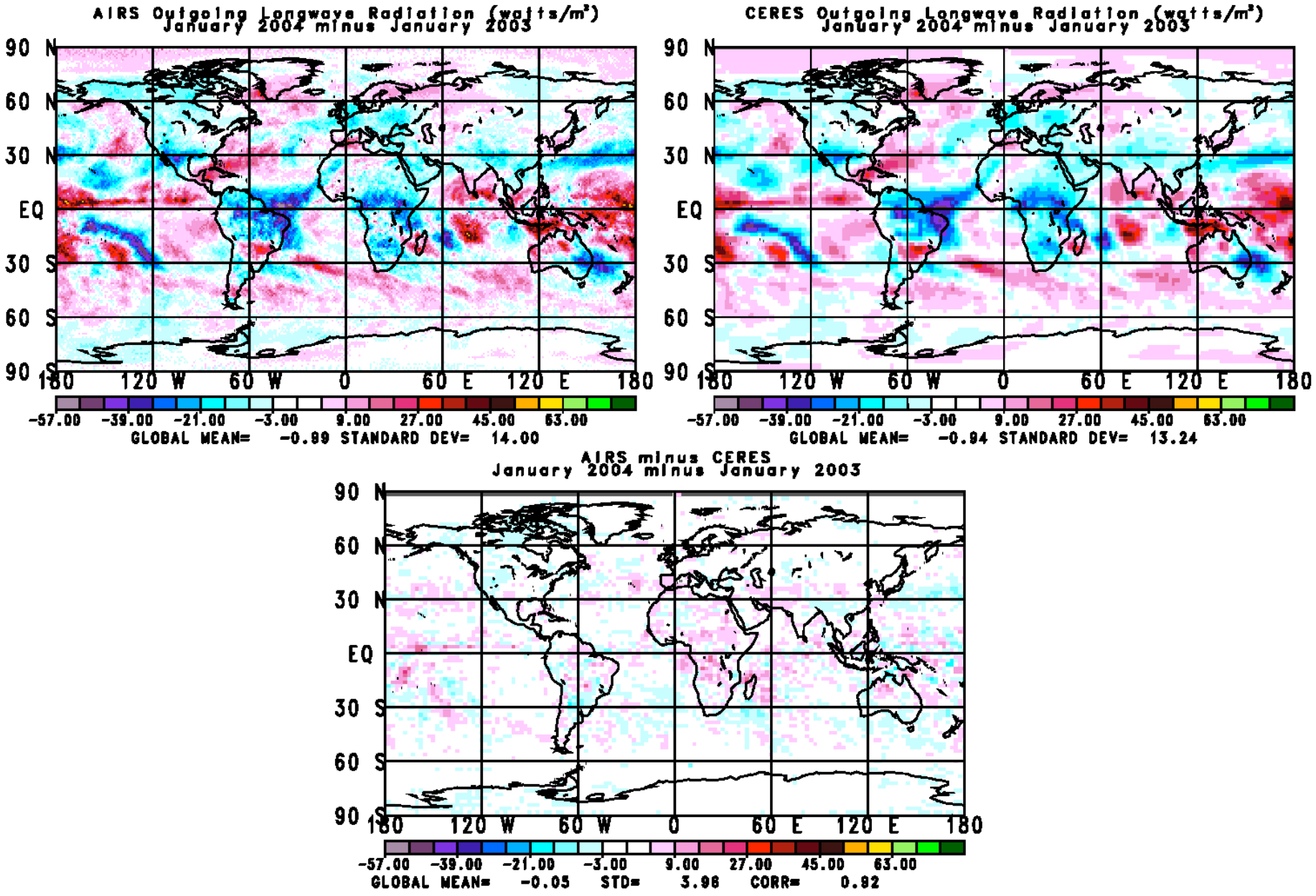
Outgoing Longwave Radiation (watts/m²)





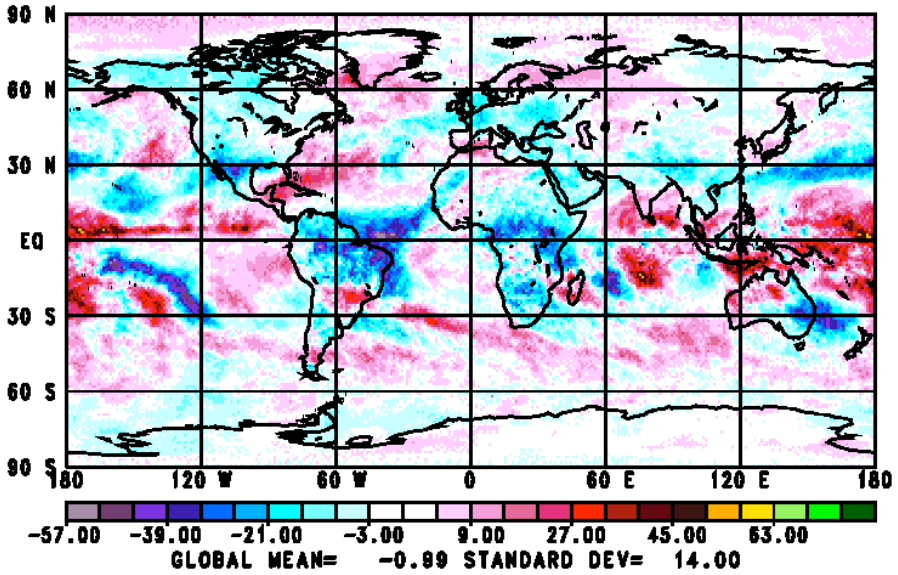


Outgoing Longwave Radiation (watts/m²)



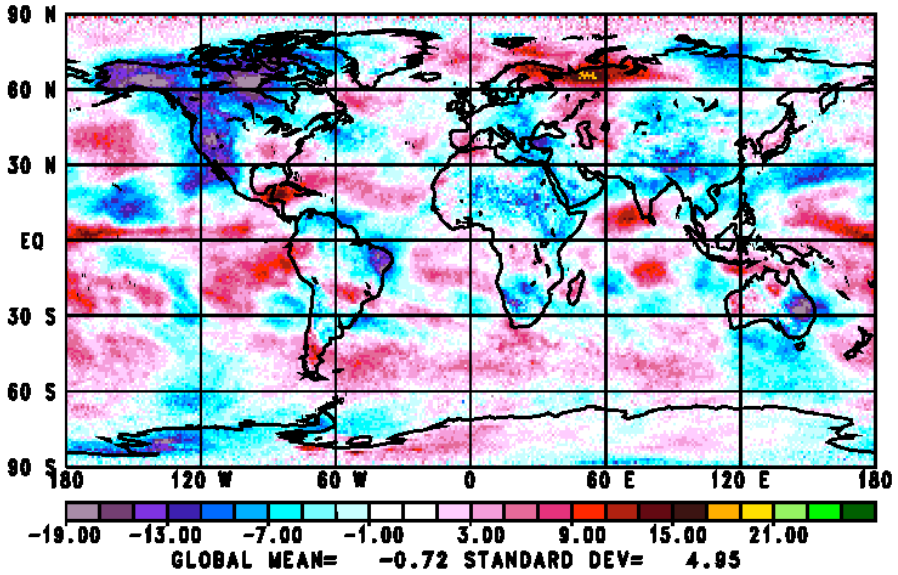
Interannual Differences
January 2004 minus January 2003

AIRS Outgoing Longwave Radiation (watts/m²)



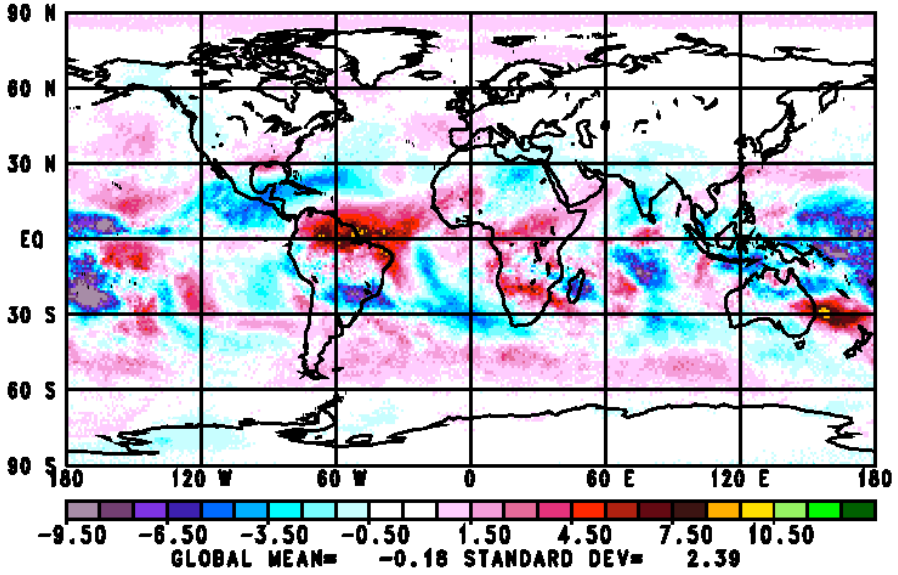
GLOBAL MEAN= -0.99 STANDARD DEV= 14.00

AIRS Clear Sky Outgoing Longwave Radiation (watts/m²)



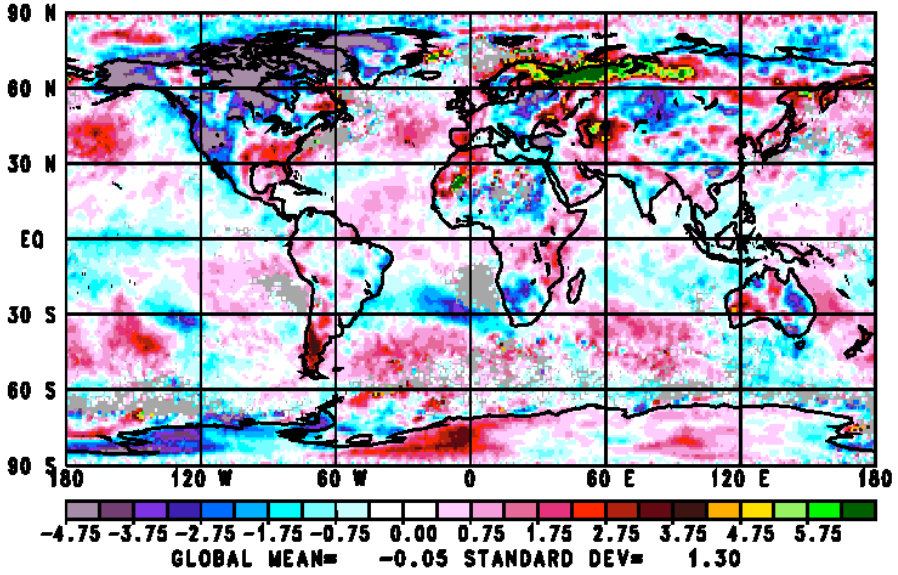
GLOBAL MEAN= -0.72 STANDARD DEV= 4.95

Precipitable Water Above 300 mb (mm*100)



GLOBAL MEAN= -0.18 STANDARD DEV= 2.39

Surface Skin Temperature (K)



GLOBAL MEAN= -0.05 STANDARD DEV= 1.30

ISSUES RELATED TO IR TUNING

We currently add $\Delta\Theta_i$ to reconstructed minus computed brightness temperatures $\left(\hat{\Theta}_i - \Theta_i^{comp}\right)$

$\Delta\Theta_i$ determined from 5138 “clear” ocean night cases 50°N - 50°S on September 6, 2002

Use for channels in the range 650 cm^{-1} - 755 cm^{-1} and 2180 cm^{-1} - 2422 cm^{-1}

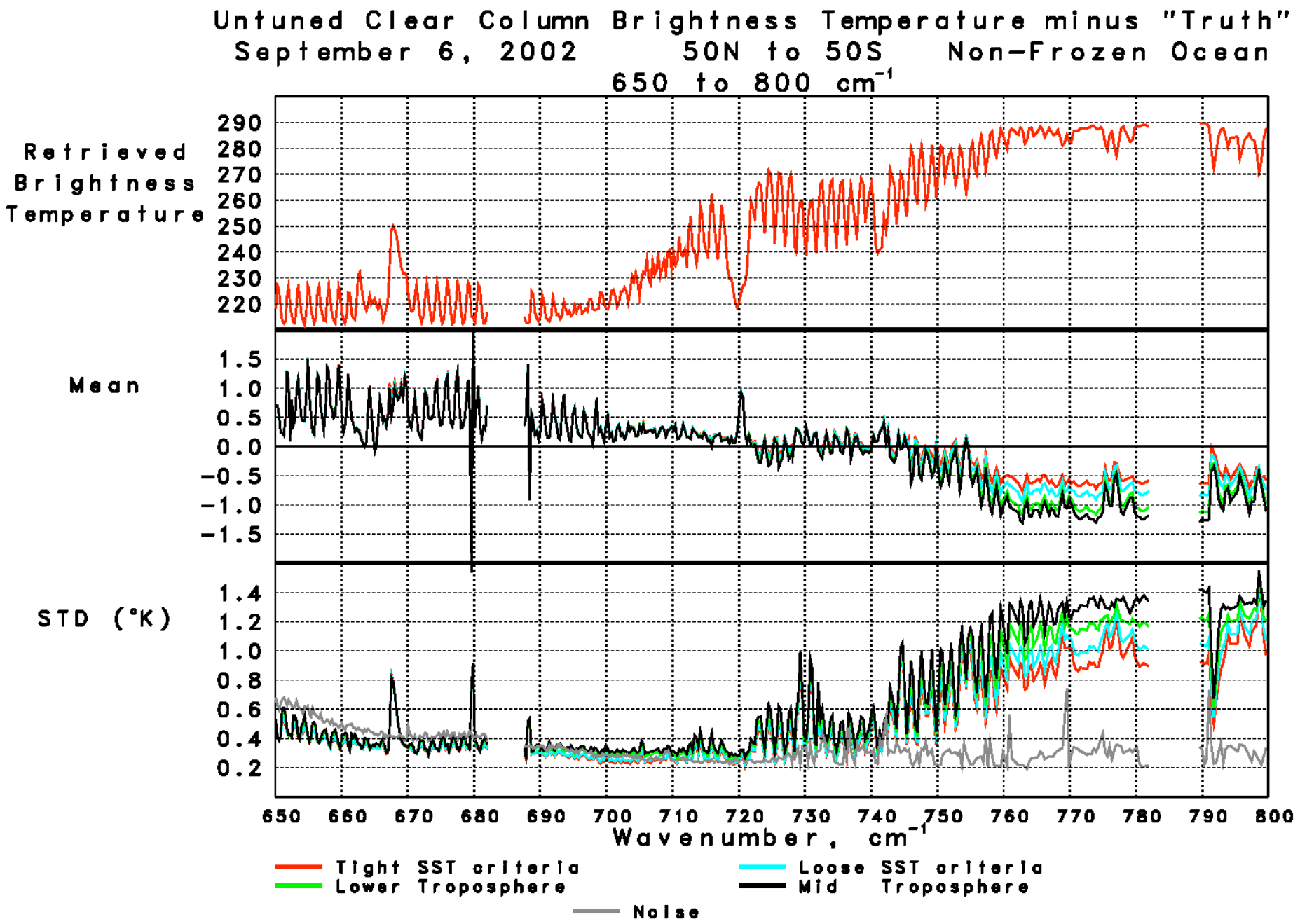
$\Delta\Theta_i$ affects cloud clearing results, retrieval results, quality flag tests

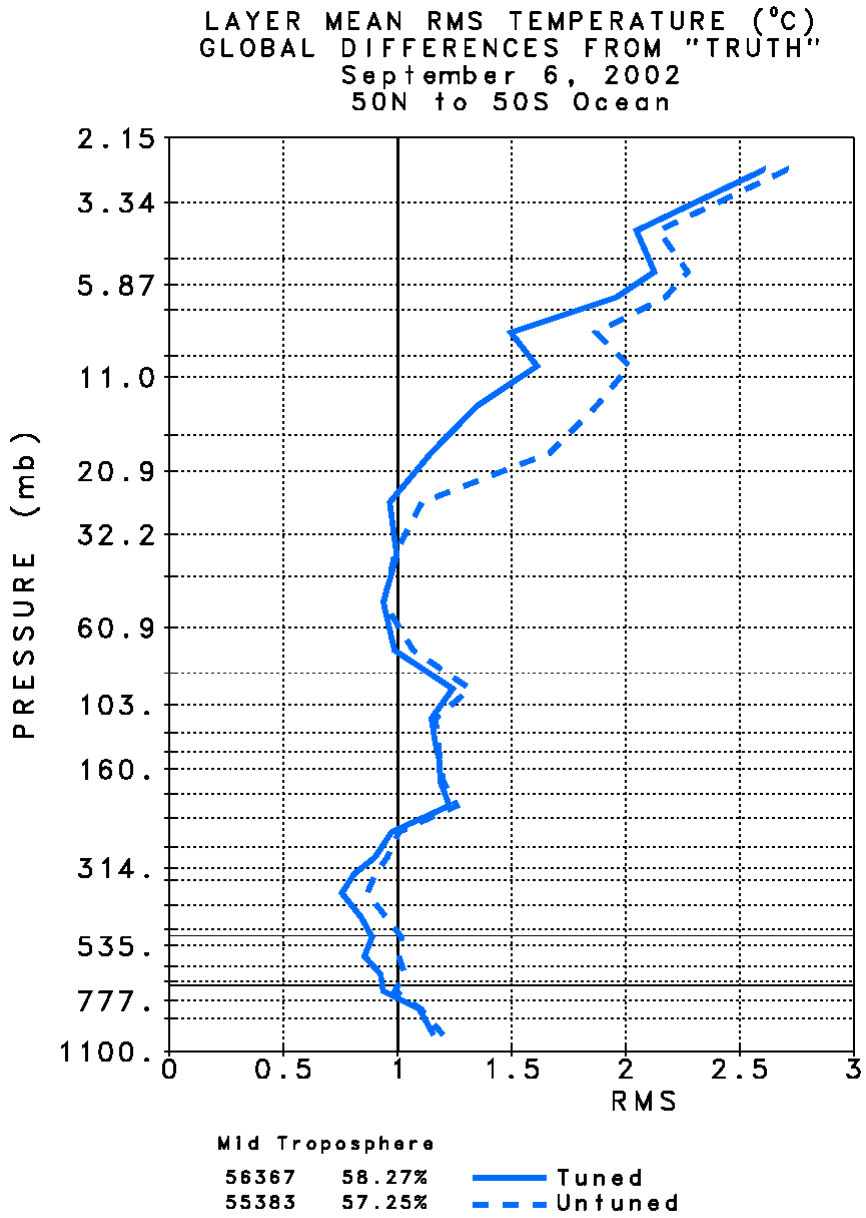
Questions

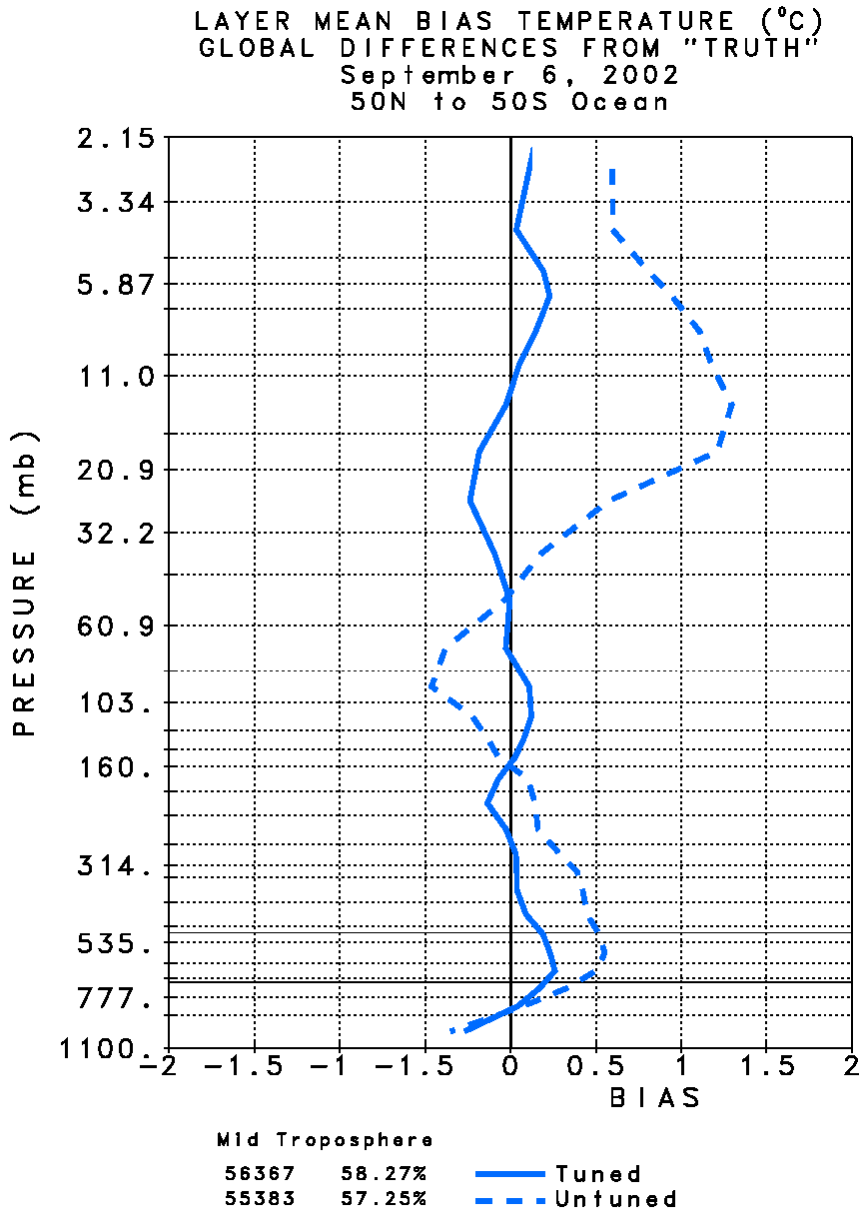
1) Is IR tuning needed in Version 5.0

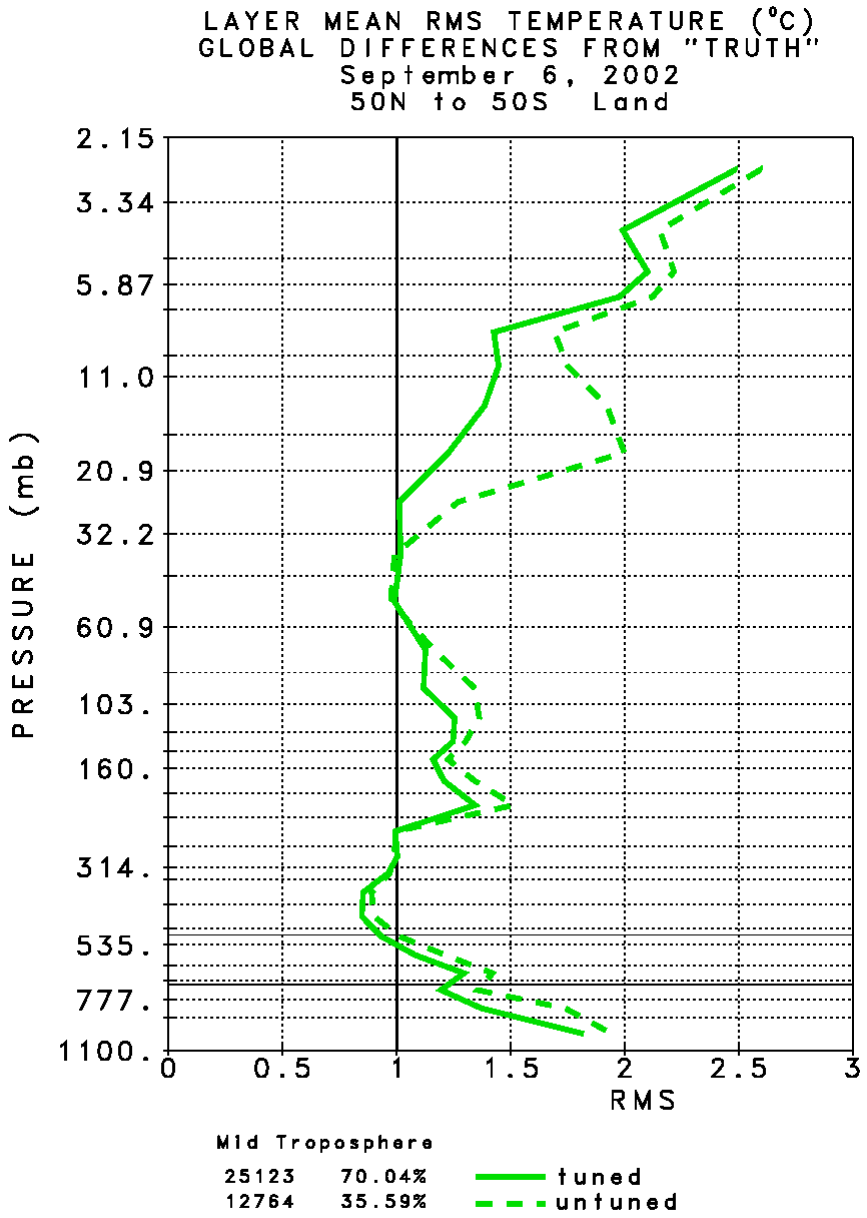
2) If it is needed, is bias tuning stable in location, time

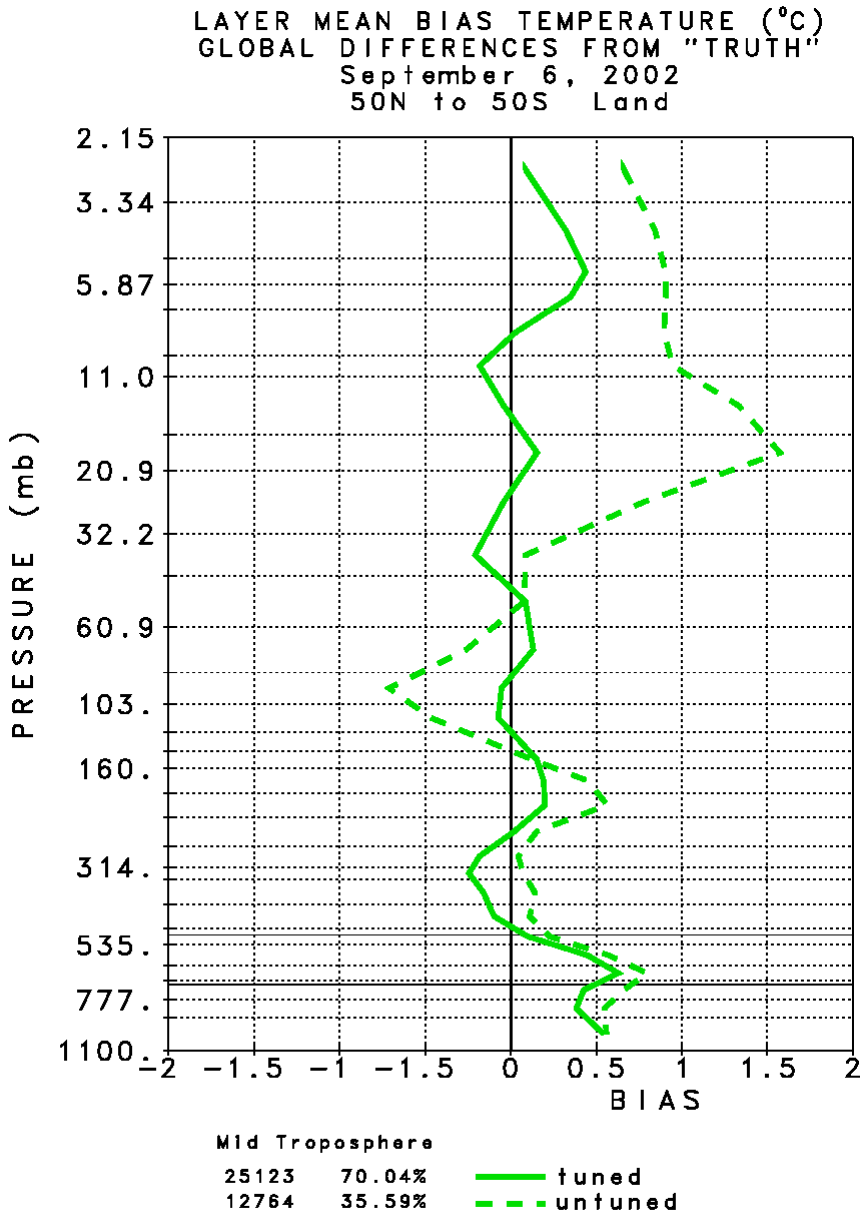
3) If 1) is true and 2) is false, can something better be done

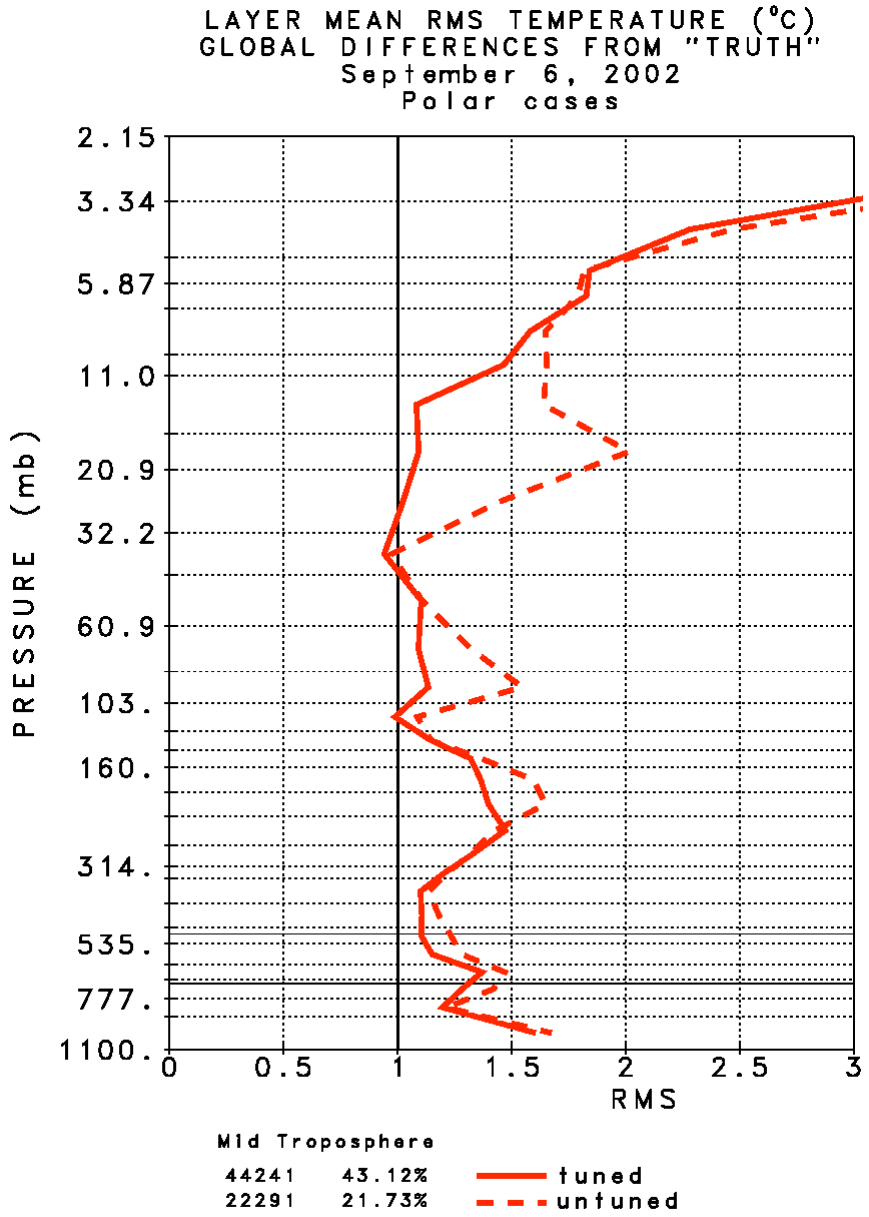

Untuned Clear Column Brightness Temperature minus "Truth"
September 6, 2002 50N to 50S Non-Frozen Ocean
650 to 800 cm-1
Retrieved Brightness Temperature
290
280
270
260
250
240
230
220
Mean
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
STD (°K)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800
Wavenumber, cm-1
Tight SST criteria
Loose SST criteria
Lower Troposphere
Mid Troposphere
Noise

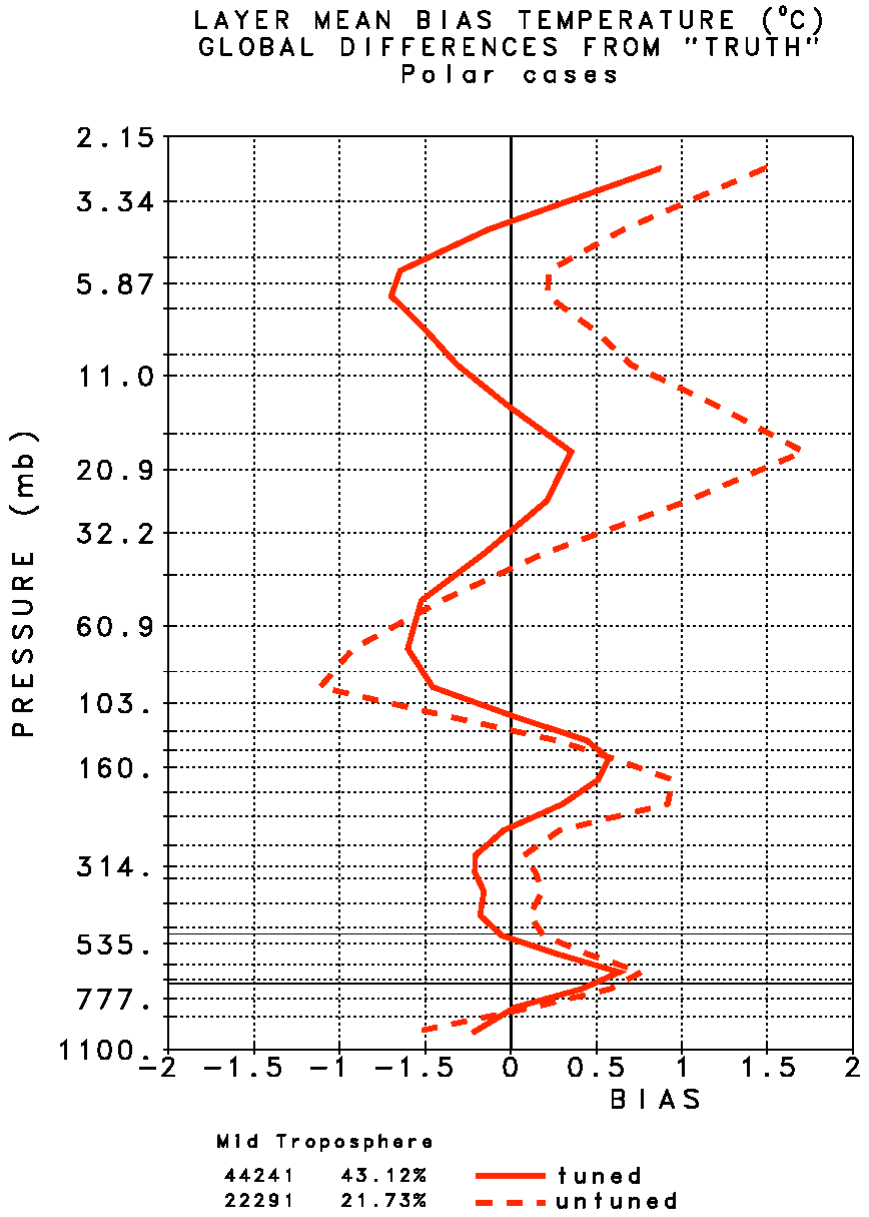

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
50N to 50S Ocean
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0
0.5
1
1.5
2
2.5
3
RMS
Mid Troposphere
56367 58.27%
55383 57.25%
Tuned
Untuned

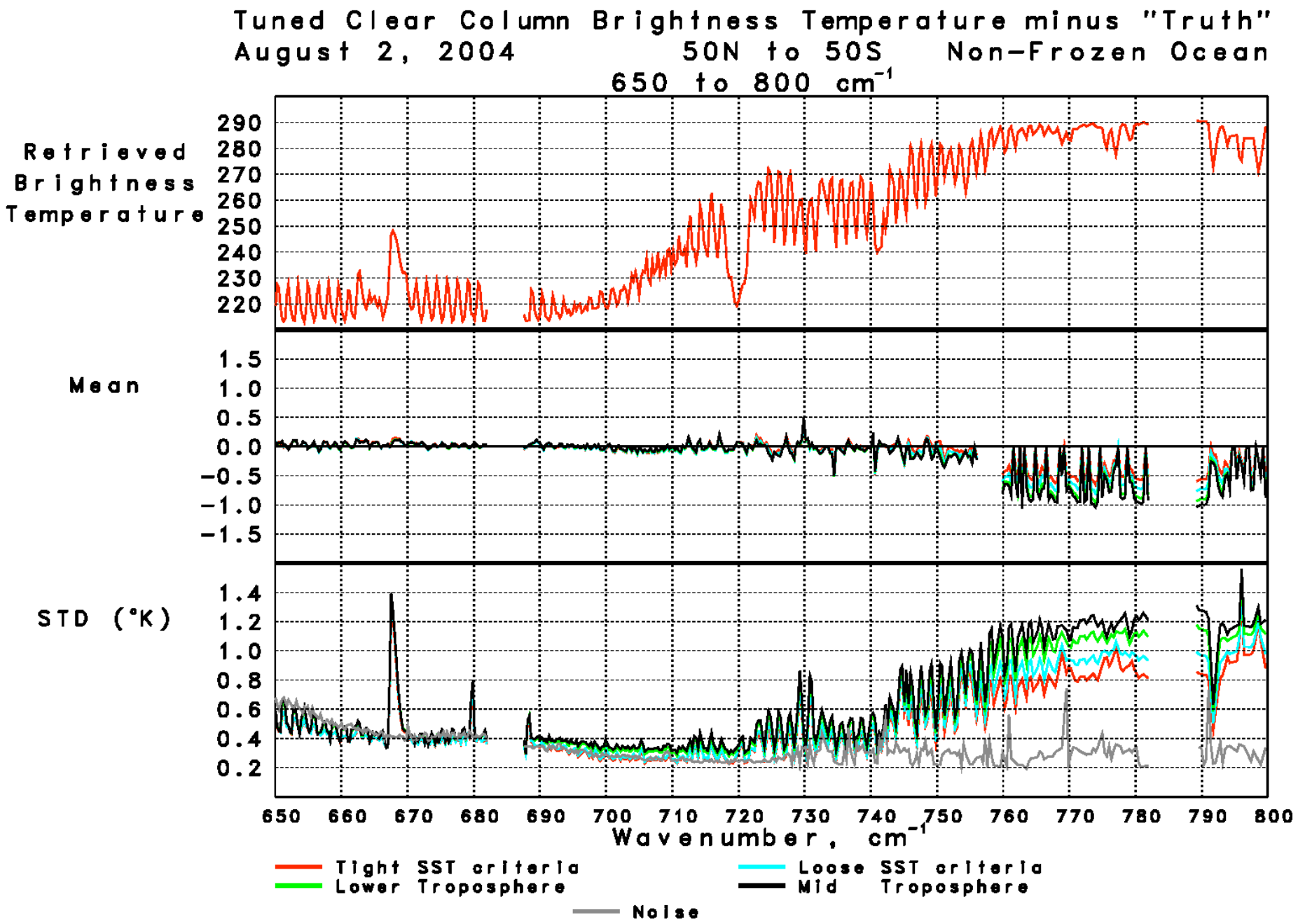

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
50N to 50S Ocean
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
−2
−1.5
−1
−1.5
0
0.5
1
1.5
2
BIAS
Mid Troposphere
56367 58.27%
55383 57.25%
Tuned
Untuned

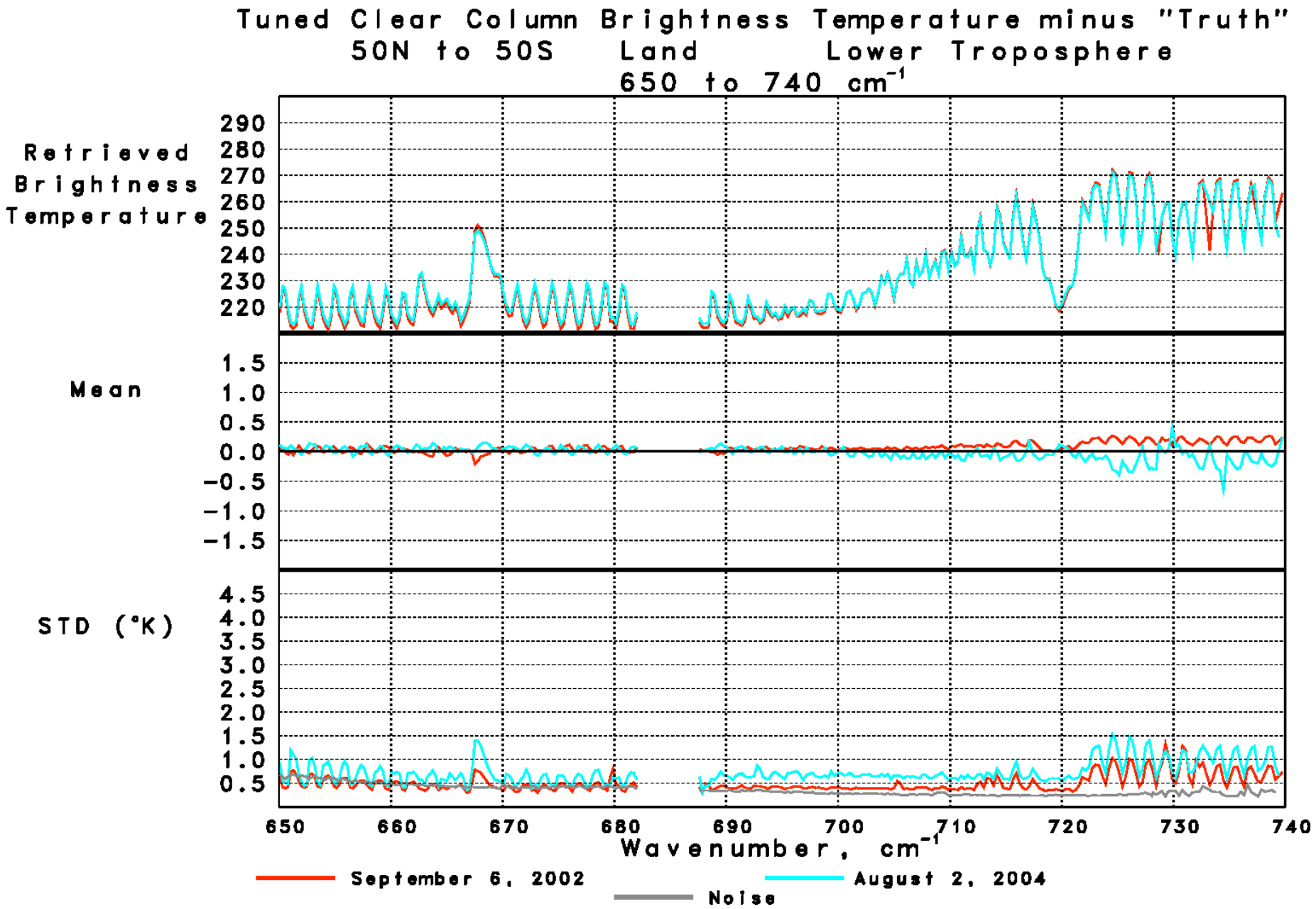

LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
50N to 50S Land
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0
0.5
1
1.5
2
2.5
3
RMS
Mid Troposphere
25123 70.04%
12764 35.59%
tuned
untuned

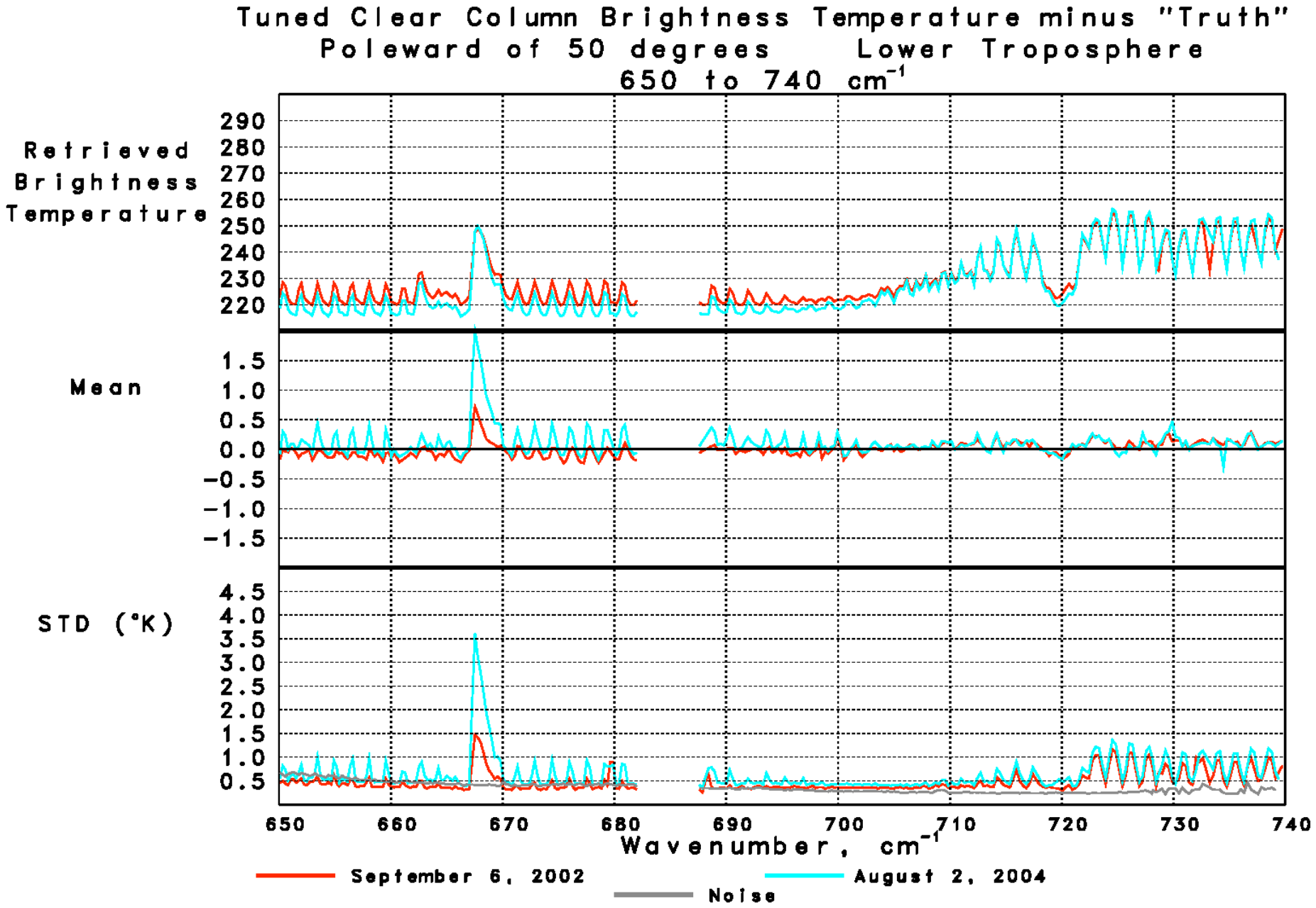

LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
50N to 50S Land
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
−2
−1.5
−1
−1.5
0
0.5
1
1.5
2
BIAS
Mid Troposphere
25123 70.04%
12764 35.59%
tuned
untuned


LAYER MEAN RMS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
September 6, 2002
Polar cases
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0
0.5
1
1.5
2
2.5
3
RMS
Mid Troposphere
44241 43.12%
22291 21.73%
tuned
untuned


LAYER MEAN BIAS TEMPERATURE (°C)
GLOBAL DIFFERENCES FROM "TRUTH"
Polar cases
PRESSURE (mb)
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
−2
−1.5
−1
−1.5
0
0.5
1
1.5
2
BIAS
Mid Troposphere
44241 43.12%
22291 21.73%
tuned
untuned


Tuned Clear Column Brightness Temperature minus "Truth"
August 2, 2004 50N to 50S Non-Frozen Ocean
650 to 800 cm-1
Retrieved Brightness Temperature
290
280
270
260
250
240
230
220
Mean
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
STD (°K)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800
Wavenumber, cm-1
Tight SST criteria
Loose SST criteria
Lower Troposphere
Mid Troposphere
Noise


Tuned Clear Column Brightness Temperature minus "Truth"
50N to 50S Land Lower Troposphere
650 to 740 cm-1
Retrieved Brightness Temperature
290
280
270
260
250
240
230
220
Mean
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
STD (°K)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
650
660
670
680
690
700
710
720
730
740
Wavenumber, cm-1
September 6, 2002
August 2, 2004
Noise


Tuned Clear Column Brightness Temperature minus "Truth"
Poleward of 50 degrees Lower Troposphere
650 to 740 cm-1
Retrieved Brightness Temperature
290
280
270
260
250
240
230
220
Mean
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
STD (°K)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
650
660
670
680
690
700
710
720
730
740
Wavenumber, cm-1
September 6, 2002
August 2, 2004
Noise

PROPOSED RESEARCH FOR VERSION 5.0

Improve IR tuning

Improve water vapor and ozone profile retrievals

- Very little attention to these steps thus far

Improve surface emissivity retrieval

Improve handling effects of uncertainty in emissivity on retrieval steps and QA flags

Further refine QA indicators

Add new climate products (Thursday's talk)